



## **EXHIBIT 2B**

# **IS856 Test Report Provided by Nortel Networks**

**Applicant: Nortel Networks**

**For Class II Permissive Change  
Certification on:**

**FCC: AB6NT1900SFRM**

**IC: 332D-1900SFRM**



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## Test Report for FCC Equipment Authorization

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## Table of Contents

Table of Contents 3

<b>1 Publication History .....</b>	<b>9</b>
1.1 List of Consultants .....	9
1.2 Decision Ratifier .....	9
1.3 Revision History .....	10
<b>2 Acronyms and Abbreviations .....</b>	<b>11</b>
<b>3 Introduction .....</b>	<b>13</b>
3.1 Required Tests .....	13
<b>4 Engineering Declaration .....</b>	<b>14</b>
<b>5 Equipment Authorization Application Requirements .....</b>	<b>15</b>
5.1 Standard Test Conditions and Test Equipment .....	15
5.2 EUT Identification List .....	15
5.3 Test Equipment List .....	15
<b>6 Transmitter Tests .....</b>	<b>17</b>
6.1 RF Power Output .....	17
6.1.1 RF Power Output Requirements .....	17
6.1.2 Test Method .....	17
6.1.3 Test Setup .....	17
6.1.4 Test Results .....	18
6.2 Occupied Bandwidth .....	19
6.2.1 Occupied Bandwidth Requirements .....	19
6.2.2 Test Method .....	19
6.2.3 Test Setup .....	19
6.2.4 Test Results .....	20
6.3 Spurious Emissions at Antenna Terminals .....	26
6.3.1 Spurious Emissions Requirements .....	26
6.3.2 Test Method .....	27
6.3.2.1 Adjacent 1MHz to indicated PCS subband (Upper and Lower) .....	28
6.3.2.2 All other Spurious Emissions up to 20 GHz .....	28
6.3.3 Test Setup .....	29
6.3.4 Test Results .....	29
<b>7 References .....</b>	<b>63</b>



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## List of Tables

Table 47 : Required Tests .....	13
Table 48 : EUT Identification List .....	15
Table 49 : Test Equipment List .....	16
Table 50 : RF Output Power of 1900 MHz SFRM Radio Module, 16QAM Mode .....	18
Table 51 : Occupied Bandwidth, 1900 MHz SFRM Radio Module, 16 QAM Mode .....	20
Table 52 : Adjacent 1 MHz Spectrum Analyzer Settings .....	28
Table 53 : All other Emissions Spectrum Analyzer Settings .....	28
Table 54 : Spurious Emissions at the 1900 MHz SFRM Radio Module DPM Antenna Port .....	30



## List of Figures

### Table of Contents 3

Figure 8 : Test Setup for RF Power Output Measurement .....	18
Figure 9 : Test Setup for Occupied Bandwidth Measurement .....	20
Figure 10 : Occupied Bandwidth - Channel 25 .....	21
Figure 11 : Occupied Bandwidth - Channel 375 .....	22
Figure 12 : Occupied Bandwidth - Channel 425 .....	23
Figure 13 : Occupied Bandwidth - Channel 775 .....	24
Figure 14 : Occupied Bandwidth - Channel 825 .....	25
Figure 15 : Occupied Bandwidth - Channel 1175 .....	26
Figure 16 : Test Setup for Spurious Emissions Measurement .....	29
Figure 17 : Conducted Spurious Emissions - Channel 25 (Lower adjacent 1 MHz) .....	32
Figure 18 : Conducted Spurious Emissions - Channel 25 (Upper Adjacent 1 MHz) .....	33
Figure 19 : Conducted Spurious Emissions - Channel 25 (9kHz :- Lower Adjacent 1 MHz) .....	34
Figure 20 : Conducted Spurious Emissions - Channel 25, (Upper Adjacent 1 MHz to 5GHz) .....	35
Figure 21 : Conducted Spurious Emissions - Channel 25 (5 GHz :- 20G GHz) .....	36
Figure 22 : Conducted Spurious Emissions - Channel 375, Lower Adjacent 1MHz .....	37
Figure 23 : Conducted Spurious Emissions - Channel 375, IS-85 (Higher Adjacent 1 MHz) .....	38
Figure 24 : Conducted Spurious Emissions - Channel 375, IS-856 (9 KHz to Lower Adjacent 1 MHz) .....	39
Figure 25 : Conducted Spurious Emissions - Channel 375 (Higher Adjacent 1 MHz to 5GHz) .....	40
Figure 26 : Conducted Spurious Emissions - Channel 375 (5 GHz to 20 GHz) .....	41
Figure 27 : Conducted Spurious Emissions - Channel 425 (Lower Adjacent 1 MHz) .....	42
Figure 28 : Conducted Spurious Emissions - Channel 425 (Upper Adjacent 1 MHz) .....	43
Figure 29 : Conducted Spurious Emissions - Channel 425 (9 KHz to Lower Adjacent 1MHz) .....	44
Figure 30 : Conducted Spurious Emissions - Channel 425 (Upper 1MHz to 5 GHz) .....	45
Figure 31 : Conducted Spurious Emissions - Channel 425 (5 GHz to 20 GHz) .....	46
Figure 32 : Conducted Spurious Emissions - Channels 775 (Lower Adjacent 1 MHz) .....	47
Figure 33 : Conducted Spurious Emissions - Channels 775 (Upper Adjacent 1 MHz) .....	48
Figure 34 : Conducted Spurious Emissions - Channel 775 (9 KHz to Lower Adjacent 1 MHz) .....	49
Figure 35 : Conducted Spurious Emissions - Channel 775 (Upper Adjacent 1 MHz to 5 GHz) .....	50
Figure 36 : Conducted Spurious Emissions - Channels 775 (5 GHz to 20 GHz) .....	51
Figure 37 : Conducted Spurious Emissions - Channel 825 (Lower Adjacent 1 MHz) .....	52
Figure 38 : Conducted Spurious Emissions - Channel 825 (Upper Adjacent 1 MHz) .....	53
Figure 39 : Conducted Spurious Emissions - Channel 825 (9 KHz to Lower Adjacent 1 MHz) .....	54
Figure 40 : Conducted Spurious Emissions - Channel 825 (Upper Adjacent 1 MHz to 5 GHz) .....	55
Figure 41 : Conducted Spurious Emissions - Channel 825 (5 GHz to 20 GHz) .....	56
Figure 42 : Conducted Spurious Emissions - Channel 1175 (Lower Adjacent 1 MHz) .....	57
Figure 43 : Conducted Spurious Emissions - Channels 1175 (Upper Adjacent 1 MHz) .....	58
Figure 44 : Conducted Spurious Emissions - Channel 1175 (9 KHz to Lower Adjacent 1 MHz) .....	59
Figure 45 : Conducted Spurious Emissions - Channels 1175 (Upper Adjacent 1 MHz to 5 GHz) .....	60
Figure 46 : Conducted Spurious Emissions - Channels 1175 (5 GHz to 20 GHz) .....	61





## Publication History

The latest controlled release of this document is located in Livelink at the following location:

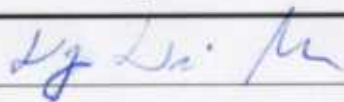
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## List of Consultants

The following people have reviewed this document prior to its release and are expected to provide recommendation for its approval:

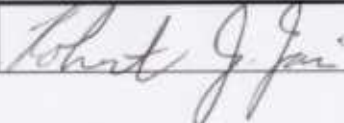
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## Decision Maker

Decision Maker's Name	Signature	Date
Thomas Wong		March 15, 2005

## Decision Ratifier

The release of this document will be reviewed and approved for distribution and use by the following:

Ratifier's Name	Signature	Date
Robert Zani		March 4, 2005

---

**Revision History**

<b>Stream/ issue</b>	<b>Revision Date</b>	<b>Reason for Change</b>	<b>Author</b>
00/0.1	Feb 8, 2005	Initial Test Report Draft Released	Dongxun Jia
00/0.2	Feb 24, 2005	Second Test Report Draft Released	Jadran Lokas
00/0.3	March 2, 2005	Review Copmments Included Test Report Draft Released	Jadran Lokas

Change bars are not used in this document.

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## Acronyms and Abbreviations

BTS	Base Station Transceiver Subsystem
BW	Bandwidth
cBTS	Compact Base Station Transceiver Subsystem
CDMA	Code Division Multiple Access
CEM	Channel Element Module
DPM	Duplexer Preselector Module
GPSTM	Global Position System Timing Module
IS	Interim Standard
PA	Power Amplifier
PC	Personal Computer
RBW	Resolution BandWidth
RF	Radio Frequency
RM	Radio Module
SA	Spectrum Analyzer
VSA	Vector Signal Analyzer



# 1 Introduction

This test report supports FCC filing for the 1900 MHz SFRM (Single Frequency Radio Module) Module in 1XEV DO IS-856 mode with DOM (Digital Optimized Module). This test report will be used as a Class II permissive change filing for FCC part 24. This filing includes single carrier mode for the 1900 MHz PCS band. The following test results include: RF Power Output, Occupied Bandwidth and Spurious Emissions at Antenna Terminals. Emissions testing was conducted at -48VDC at room temperature. The IS-856 modulation schemes is used in this report.

This test report is submitted in accordance with the FCC Rules and Regulations, Part 2, Subpart J, Sections 2.1046 through 2.1057 for equipment authorization of Nortel Networks’s 1900 MHz SFRM Radio Module.

The 1900 MHz SFRM Radio Module is intended for use in the Domestic Public Personal Communications Service area and is designed in accordance with the following standards:

- *CFR 47, Part 24, Subpart E, Broadband Personal Communications Service [1]*
- *CFR 47, Part 2, Subpart J, Equipment Authorization Procedures - Equipment Authorization [2]*
- *IC RSS-133, Issue 2, 2 GHz Personal Communication Services [3]*
- *ANSI-97-E, Recommended Minimum Performance Standards for cdma2000 Spread Spectrum Base Stations [4]*

## 1.1 Required Tests

Table 1 summarizes the required tests for the 1900 MHz SFRM and DOM.

**Table 1 : Required Tests**

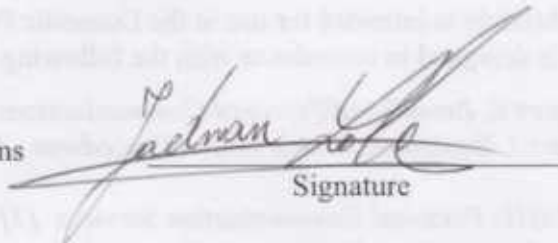
FCC Measurement Specification	FCC Limit Specification	Description	Test to be Performed?
2.1046	24.232	RF Power Output	Yes
2.1049	24.131	Occupied Bandwidth	Yes
2.1051, 2.1057	24.238	Spurious Emissions at Antenna Terminals	Yes

## 2 Engineering Declaration

The CDMA 1900 MHz SFRM (Single-Channel Flexible Radio Module) have been tested in accordance with the requirements contained in the Federal Communications Commission Rules and Regulations Part 2 and 24.

To the best of my knowledge, these tests were performed in accordance with good engineering practices using measurement procedures consistent with industry or commission standards or previous Commission correspondence or guidance and demonstrate that this equipment complies with the appropriate standards. All tests were conducted on a representative sample of the equipment for which equipment authorization is sought.

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### 3 Equipment Authorization Application Requirements

#### 3.1 Standard Test Conditions and Test Equipment

The 1900 MHz SFRM will be tested under the following standard test conditions unless otherwise noted:

- Ambient Temperature: 20 to 35 degrees C
- Ambient Humidity: 20 to 40%
- DC Supply Voltage: -48 Vdc (Nominal)
- Supported Modulations: IS-856 (16-QAM)

#### 3.2 EUT Identification List

Table 2 shows the identification of the components required for testing.

**Table 2 : EUT Identification List**

Equipment Description	Model / Part Number	Release Number	Serial Number
1900 MHz Single-Channel Flexible Transceiver Module	NTGS58CA	FX	NNTM5357KB3G
1900 MHz Power Amplifier Module	NTGS57AA	AY	NNTM53779VTG
A/D Band Duplexer and Preselector Module	NTGS53JA	05	CLWVPP20ITMG
B/E Band Duplexer and Preselector Module	NTGS53KA	06	CLWVPP202YZ5
C/F Band Duplexer and Preselector Module	NTRGS53LA	09	ALLG740001S2
DOM Module	NTBW99DO	03	ARVN30420020
CM-2 Control Module	NTBW40BA		NNTM74X)XH53
CORE-2 Module	NTBW30BA	03	NNTM84C02BE0
GPS Timing Module	NTBW50AA	08	NNTM74TCOCG3

#### 3.3 Test Equipment List

Table 3 shows the identification of the test equipment required for testing.



**Table 3 : Test Equipment List**

<b>Description</b>	<b>Manufacturer</b>	<b>Model</b>	<b>Serial/Batch Number</b>	<b>Cal. Due Date</b>
3 Hz to 26.5 GHz Cell Site Tester	Agilent	PSA E4440A	MY44022812	Jun. 3, 2005
RF Power Meter	HP	EPM-442A	US37480287	Nov. 15, 2005
RF Power Sensor Head	HP	8482A	US37293538	Apr. 29, 2005
30dB Attenuator	Weinshel	48-30-43	BJ2527	Verified
20 dB Attenuator	Suhner	6620.19AA	N/A	Verified
RFCoaxial Cable	Sucoflex	102EA	753/2EA	Verified
RFCoaxial Cable	Nortel	NTGS8061		
RFCoaxial Cable	Nortel	NTGS8061		

## 4 Transmitter Tests

### 4.1 RF Power Output

#### 4.1.1 RF Power Output Requirements

##### FCC Part 2.1046

*(a) For transmitters other than single sideband, independent sideband and controlled carrier radiotelephone, power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of current and voltage on the circuit elements specified in Sec. 2.1033(c)(8). The electrical characteristics of the radio frequency load attached to the output terminals when this test is made shall be stated.*

##### **FCC Limit (Subpart E--Broadband PCS, Sec. 24.232 Power and antenna height limits.)**

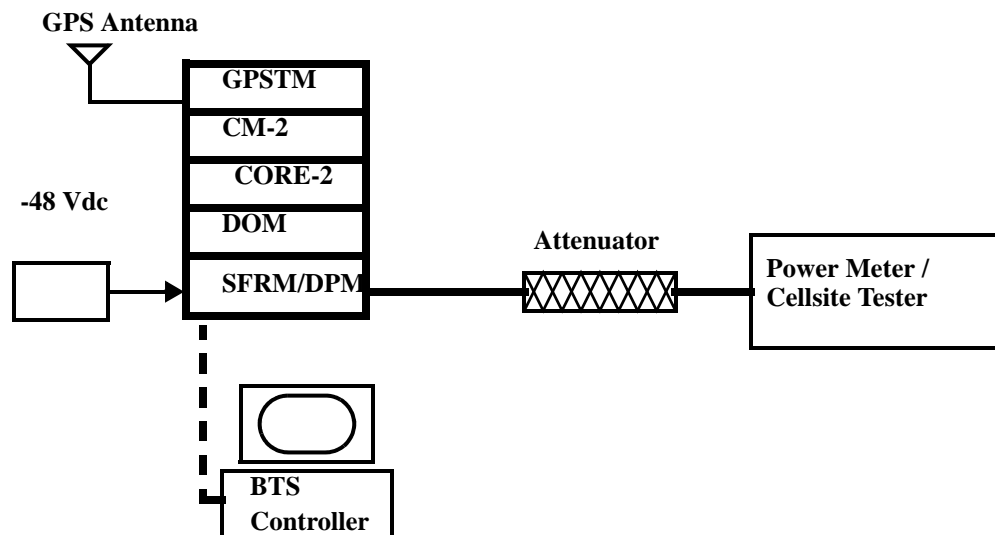
*In no case may the peak output power of a base station transmitter exceed 100 watts.*

#### 4.1.2 Test Method

The MetroCell is setup via the BTS controller to enable the 1900 MHz SFRM to transmit at maximum rated output power level. Measurements are made on channels at the bottom and top of the licensed sub-bands.

#### 4.1.3 Test Setup

The set-up used for the SFRM 1900 MHz Radio Module RF power output test is illustrated in Figure 1. RF power output measurements are referenced to the DPM antenna port.



**Figure 1 : Test Setup for RF Power Output Measurement**

#### 4.1.4 Test Results

The 1900 MHz SFRM Radio Module complies with the requirement. The RF power output measured for each of the licensed subbands are shown in Table 4, the maximum measured RF output power from the 1900 MHz SFRM Radio Module was 42.77 dBm.

**Table 4 : RF Output Power of 1900 MHz SFRM Radio Module, 16QAM Mode**

Channel Number (Band)	Frequency (MHz) (centre channel)	Measured RF Output Power (dBm)	Typical Maximum Rated Power (dBm)	FCC Limit (dBm)
25 (A)	1931.25	42.70	42.3	50
375 (D)	1948.75	42.74	42.3	50
425 (B)	1951.25	42.72	42.3	50
775 (E)	1968.75	42.77	42.3	50
825 (F)	1971.25	42.51	42.3	50
1175 (C)	1988.75	42.60	42.3	50

## 4.2 Occupied Bandwidth

### 4.2.1 Occupied Bandwidth Requirements

#### FCC Part 2.1049

*The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured under the following conditions as applicable:*

*(g) Transmitters in which the modulating baseband comprises not more than three independent channels--when modulated by the full complement of signals for which the transmitter is rated. The level of modulation for each channel should be set to that prescribed in rule parts applicable to the services for which the transmitter is intended. If specific modulation levels are not set forth in the rules, the tests should provide the manufacturer's maximum rated condition.*

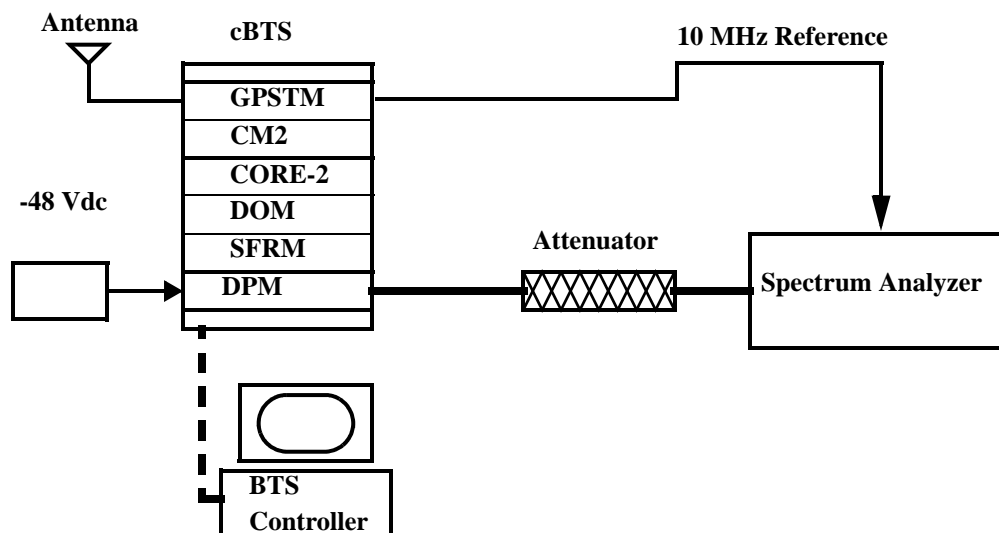
*(h) Transmitters employing digital modulation techniques--when modulated by an input signal such that its amplitude and symbol rate represent the maximum rated conditions under which the equipment will be operated. The signal shall be applied through any filter networks, pseudo-random generators or other devices required in normal service. Additionally, the occupied bandwidth shall be shown for operation with any devices used for modifying the spectrum when such devices are optional at the discretion of the user.*

### 4.2.2 Test Method

The Metrocell is setup via the BTS controller to enable the 1900 MHz SFRM Radio Module to transmit at maximum rated output power level. Measurements are made on channels at the bottom and top of the licensed sub-bands. The occupied bandwidth is measured using the 99% channel power feature of the PSA E4440A

### 4.2.3 Test Setup

The set-up used for the 1900 MHz SFRM Radio Module Occupied bandwidth test is illustrated in Figure 2.



**Figure 2 : Test Setup for Occupied Bandwidth Measurement**

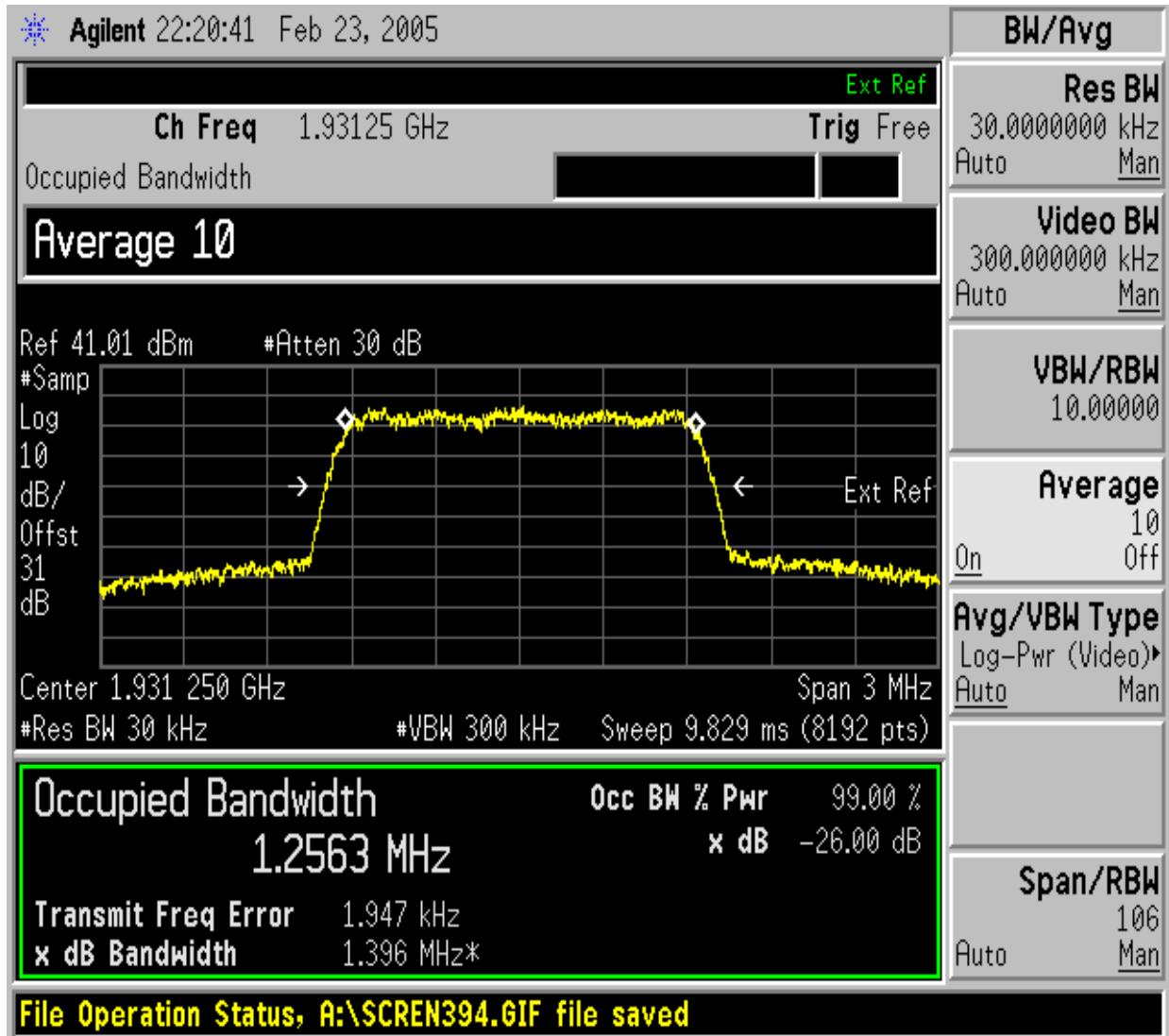
**4.2.4 Test Results**

The 1900 MHz SFRM Radio Module complies with the requirement. The occupied bandwidth measured in each of the licensed subbands and supported modulation formats is shown in Table 5

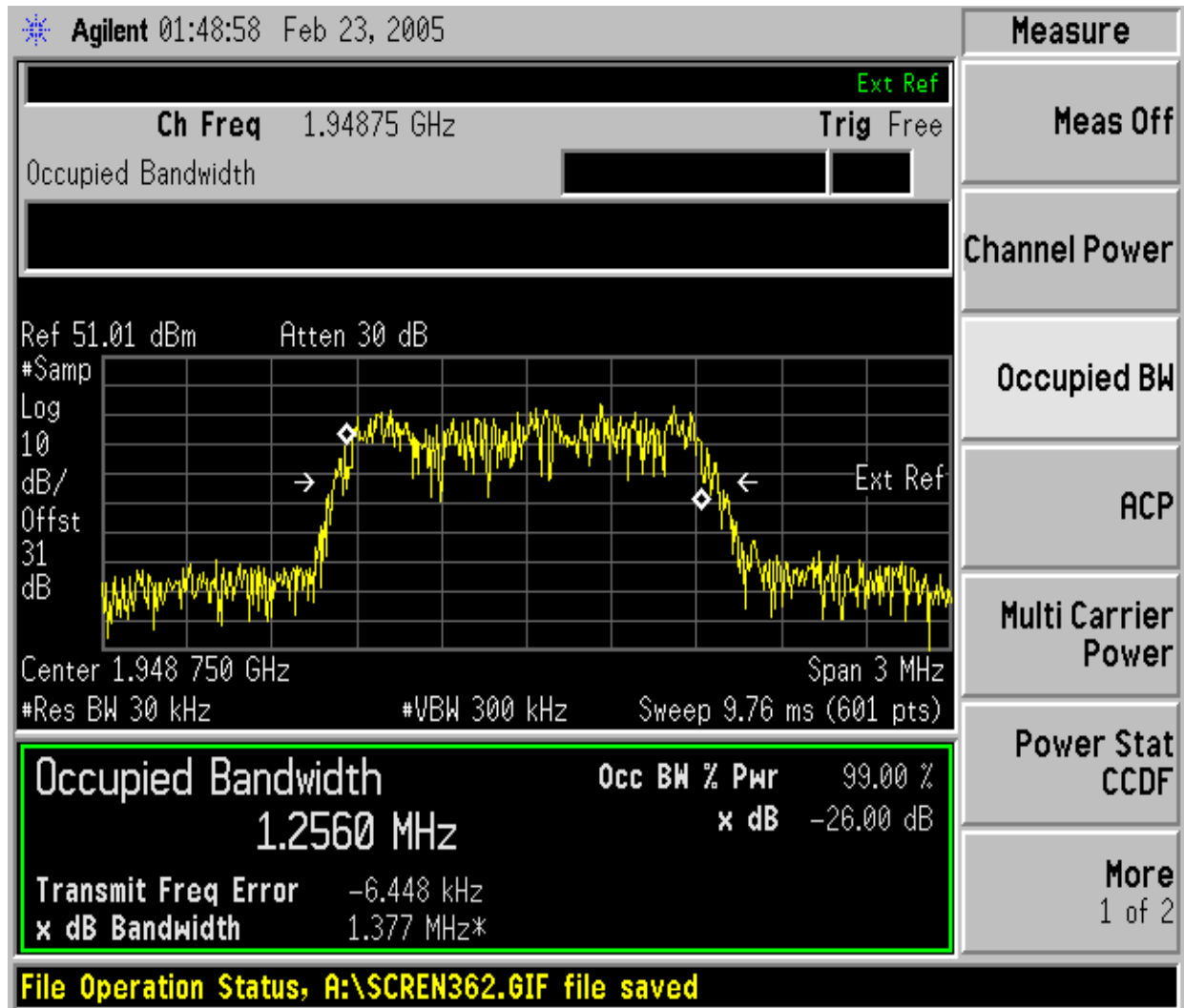
**Table 5 : Occupied Bandwidth, 1900 MHz SFRM Radio Module, 16 QAM Mode**

Channel Number (Band)	Frequency (MHz) (centre channel)	Measured Occupied Bandwidth (MHz)
25 (A)	1931.25	1.2563
375 (D)	1948.75	1.2560
425 (B)	1951.25	1.2591
775 (E)	1968.75	1.2548
825 (F)	1971.25	1.2511
1175 (C)	1988.75	1.2546

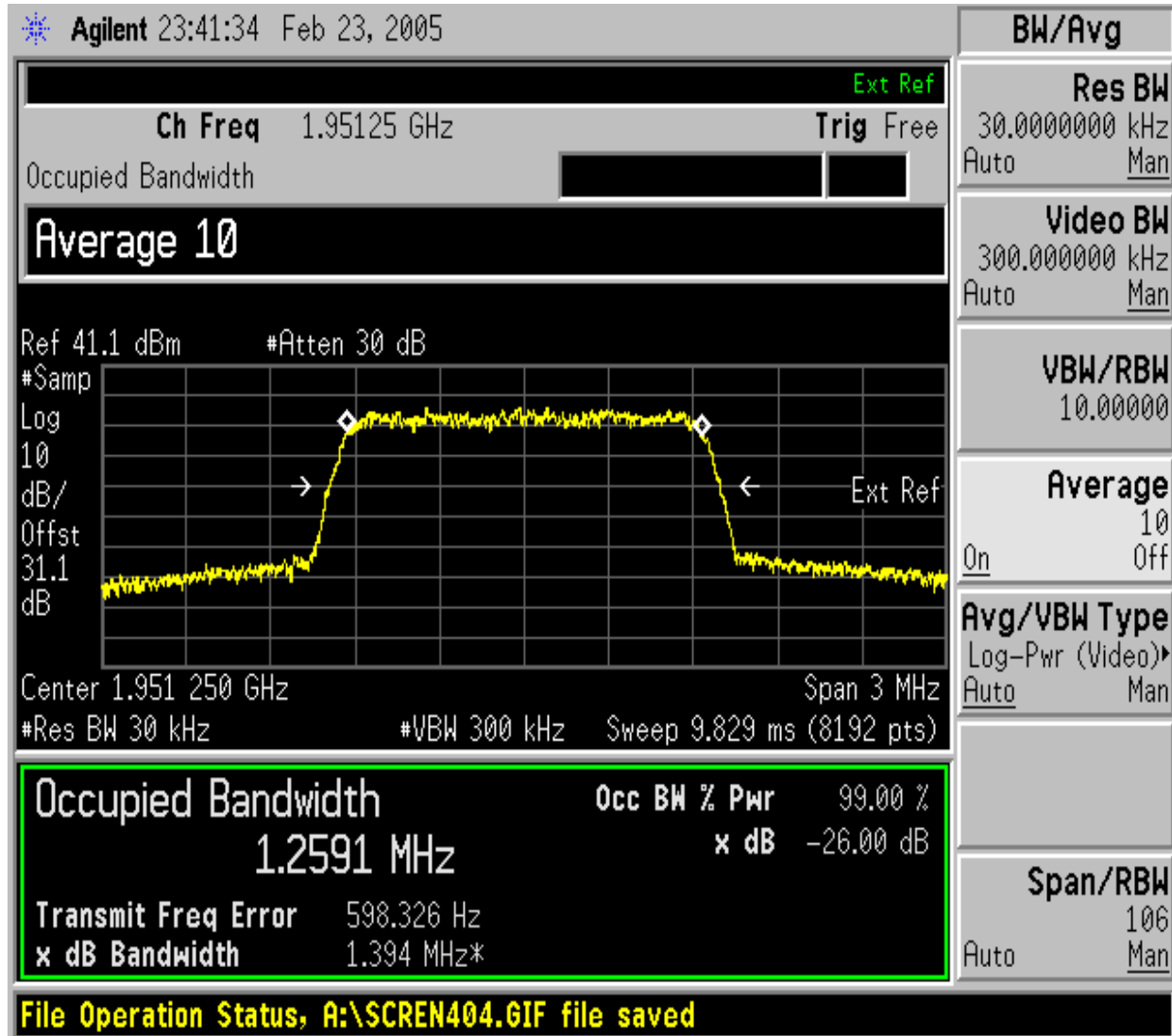
**Figure 3 : Occupied Bandwidth - Channel 25**



**Figure 4 : Occupied Bandwidth - Channel 375**

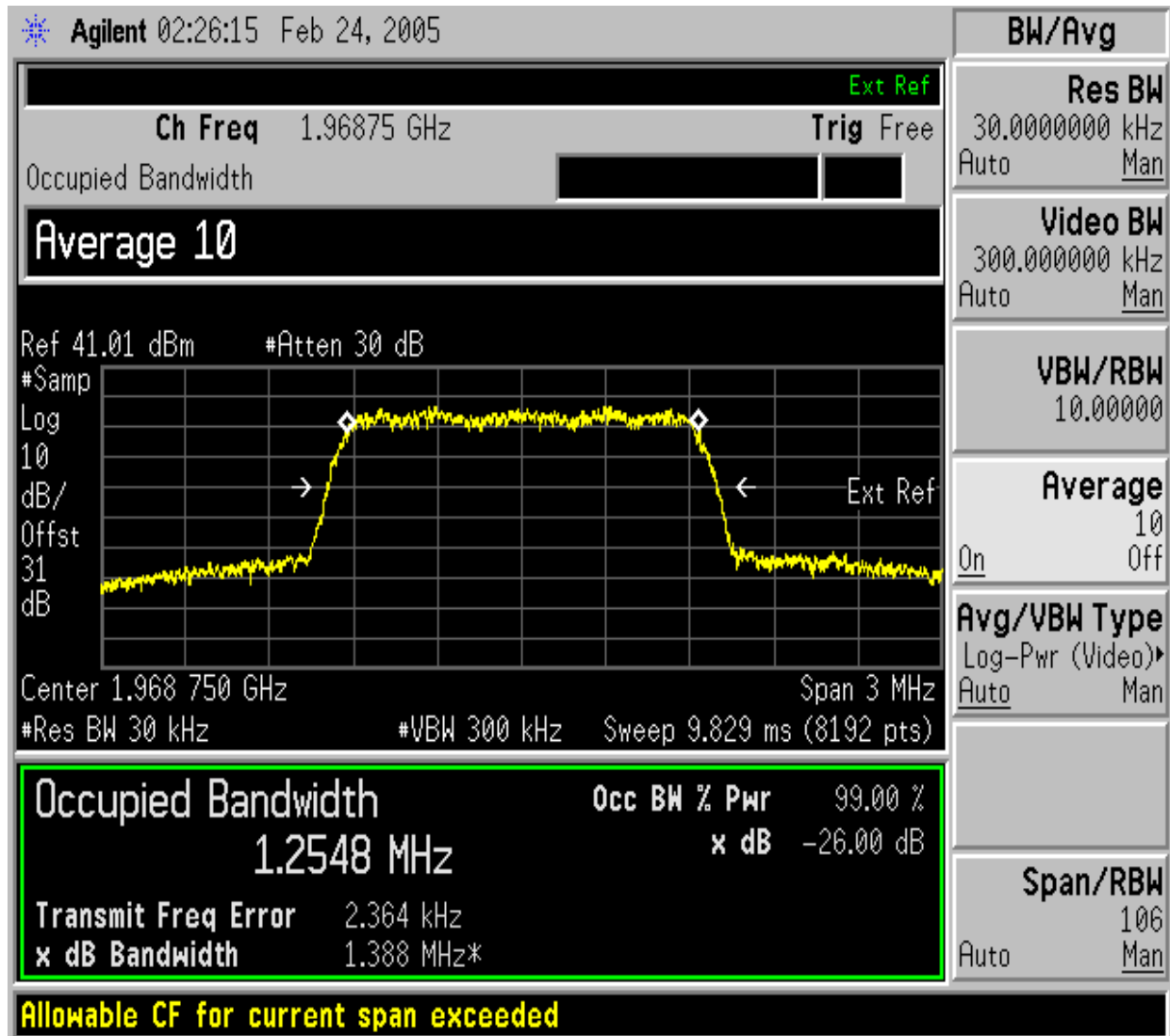


**Figure 5 : Occupied Bandwidth - Channel 425**

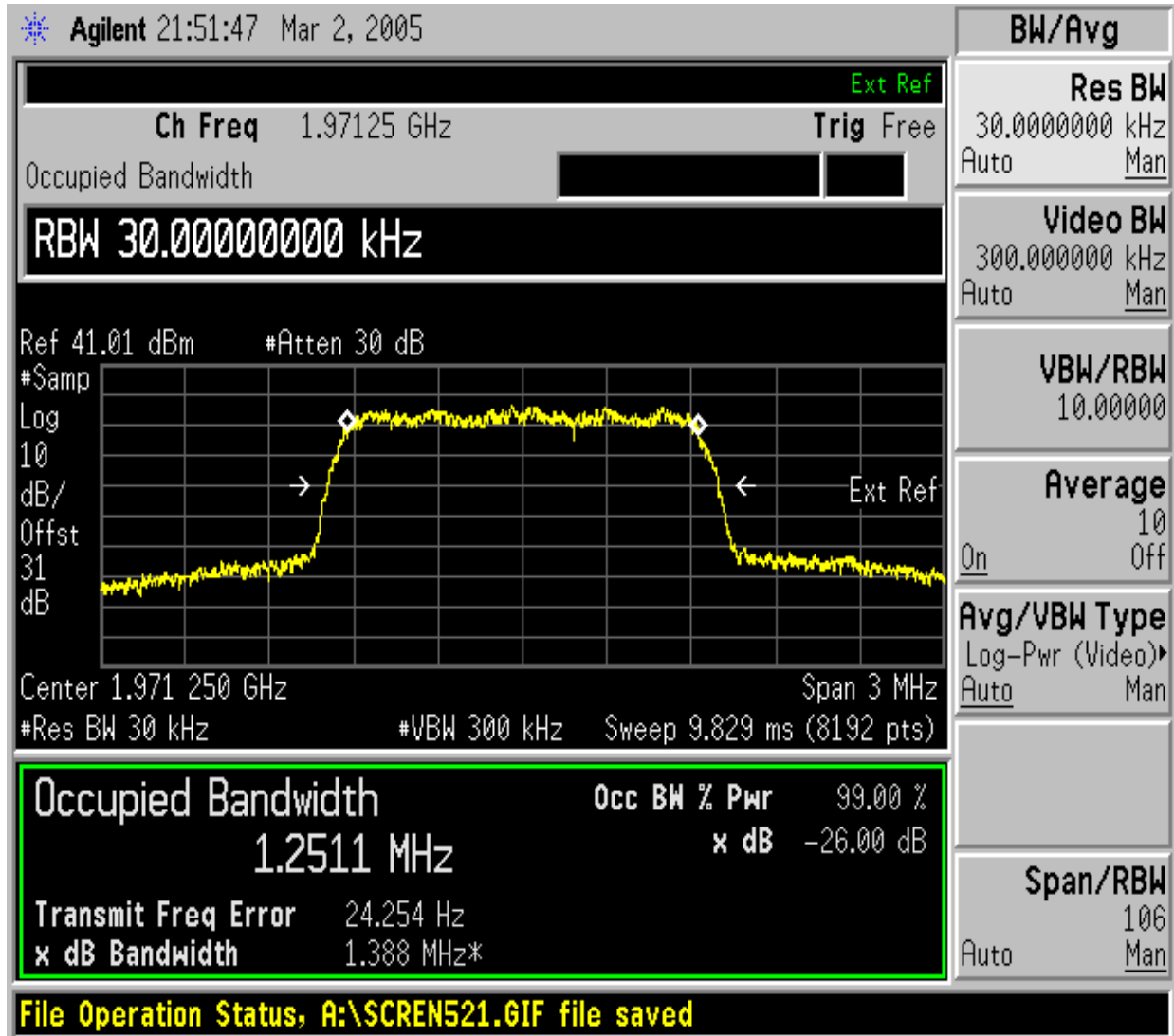




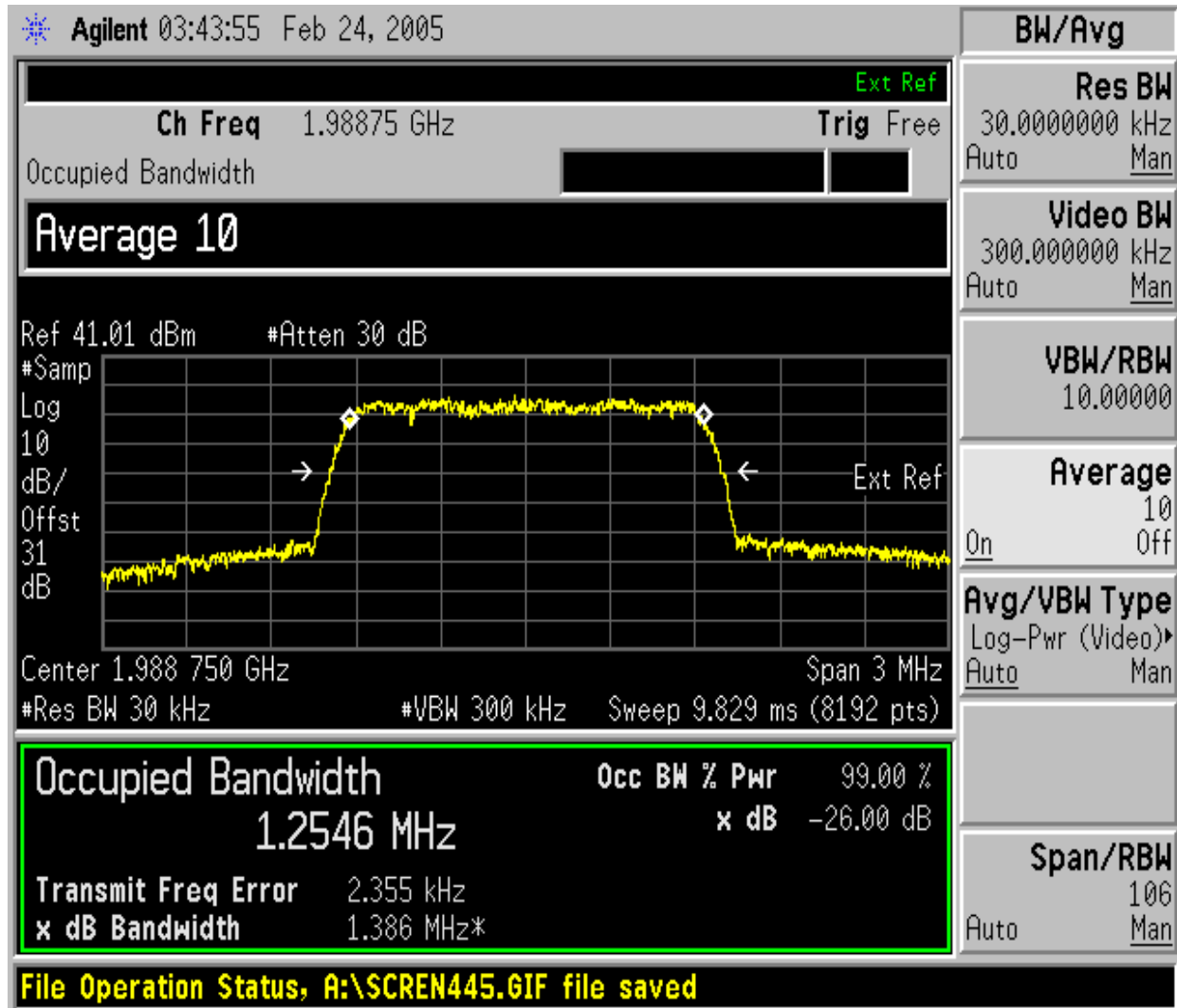
**Figure 6 : Occupied Bandwidth - Channel 775**



**Figure 7 : Occupied Bandwidth - Channel 825**



**Figure 8 : Occupied Bandwidth - Channel 1175**



### 4.3 Spurious Emissions at Antenna Terminals

#### 4.3.1 Spurious Emissions Requirements

FCC Part 2.1051

*The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in Sec. 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.*

#### **FCC Part 2.1057 - Frequency Spectrum to be investigated**

*(a) In all of the measurements set forth in Sec. 2.1051, the spectrum shall be investigated from the lowest radio frequency signal generated in the equipment, without going below 9 kHz, up to at least the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.*

*(b) Particular attention should be paid to harmonics and subharmonics of the carrier frequency as well as to those frequencies removed from the carrier by multiples of the oscillator frequency. Radiation at the frequencies of multiplier stages should also be checked.*

*(c) The amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be reported.*

#### **FCC Part 24.238 Limit**

*(a) On any frequency outside a licensee's frequency block, the power of any emission shall be attenuated below the transmitter power ( $P$ ) by at least  $43 + 10 \log (P)$  dB.*

*(b) Compliance with these provisions is based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or greater. However, in the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.*

*(c) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the licensee's frequency block edges, both upper and lower, as the design permits.*

*(d) The measurements of emission power can be expressed in peak or average values, provided they are expressed in the same parameters as the transmitter power.*

### **4.3.2 Test Method**

The MetroCell is setup via the BTS controller to enable the 1900 MHz SFRM Radio Module to transmit at maximum rated output power level. Measurements are made on channels at the bottom

and top of the licensed sub-bands. The following spectrum analyzer settings are used for the measurement of the DPM antenna port spurious emissions:

#### 4.3.2.1 Adjacent 1MHz to indicated PCS subband (Upper and Lower)

**Table 6 : Adjacent 1 MHz Spectrum Analyzer Settings**

Setting	1 Carrier
Resolution Bandwidth <sup>1</sup>	12 kHz
Video Bandwidth <sup>2</sup>	120 kHz
Video Average	10 Averages
Span	1 MHz
Attenuation <sup>3</sup>	30 dB
Ref. Level	set accordingly dBm
Ref. Level Offset	set accordingly dB

1. If the spectrum analyzer can not be set to the specified RBW, the next highest RBW should be used and all measurements corrected to the specified RBW
2. If the spectrum analyzer can not be set to the specified VBW, the next highest VBW should be used
3. The lowest value of attenuation should be used to improve measurement accuracy, without over-driving the Spectrum Analyzer. It is recommended that at least 10 dB SA internal attenuation is switched-in at all times to improve SA/Cable Interface RF match to 50 ohms.

All spectrum analyzer settings are coupled as per the manufacturers recommendations to improve measurement time, without compromising data.

#### 4.3.2.2 All other Spurious Emissions up to 20 GHz

**Table 7 : All other Emissions Spectrum Analyzer Settings**

Setting	1 Carrier
Resolution Bandwidth	1 MHz
Video Bandwidth	8 MHz
Video Average	10 Averages
Span	set accordingly
Attenuation <sup>1</sup>	30 dB
Ref. Level	set accordingly dBm
Ref. Level Offset	set accordingly dB

1. The lowest value of attenuation should be used to improve measurement accuracy, without over-driving the Spectrum Analyzer. It is recommended that at least 10 dB SA internal attenuation is switched-in at all times to improve SA/Cable Interface RF match to 50 ohms.

### 4.3.3 Test Setup

The set-up used for the 1900 MHz SFRM Radio Module Antenna Port Spurious Emission test is illustrated in Figure 9

The conducted spurious emissions of the 1900 MHz SFRM Radio Module, with IS-856, 1xEV DO waveforms (QAM16 modulation) were tested at typical maximum output power.

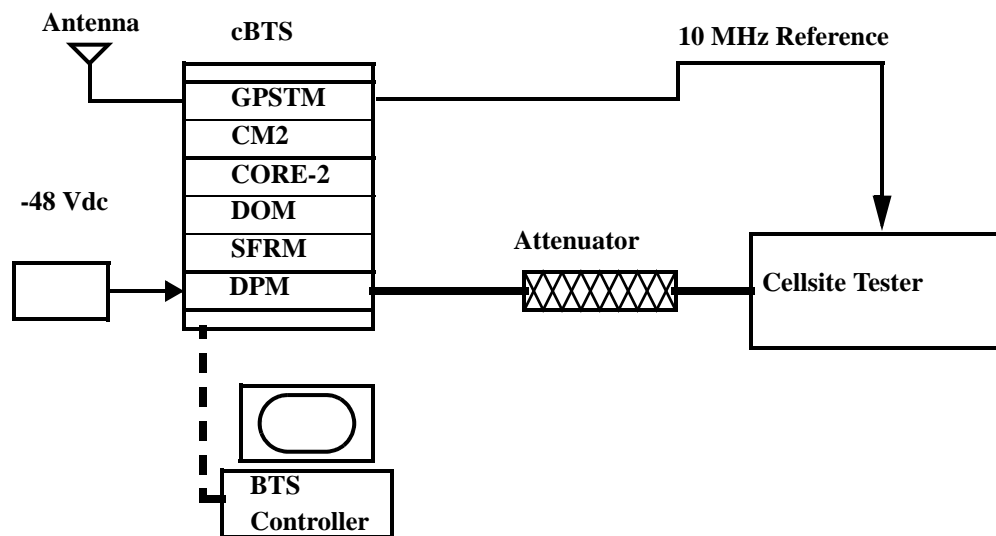


Figure 9 : Test Setup for Spurious Emissions Measurement

### 4.3.4 Test Results

The frequency spectrum from 1 MHz to 20 GHz is scanned for emissions using the cellsite tester settings outlined in 4.3.2. Measurements are made at room temperature on channels at the bottom and top of the licensed sub-bands. The SFRM 1900MHz complies with the limit of -13 dBm per 1% of occupied BW in the 1MHz band adjacent to the operator bands, and -13 dBm per 1MHz for the rest of the spectrum from 9kHz to 20GHz.. Table 8 shows the spurious emissions at the DPM antenna port of the 1900 MHz SFRM Radio Module.

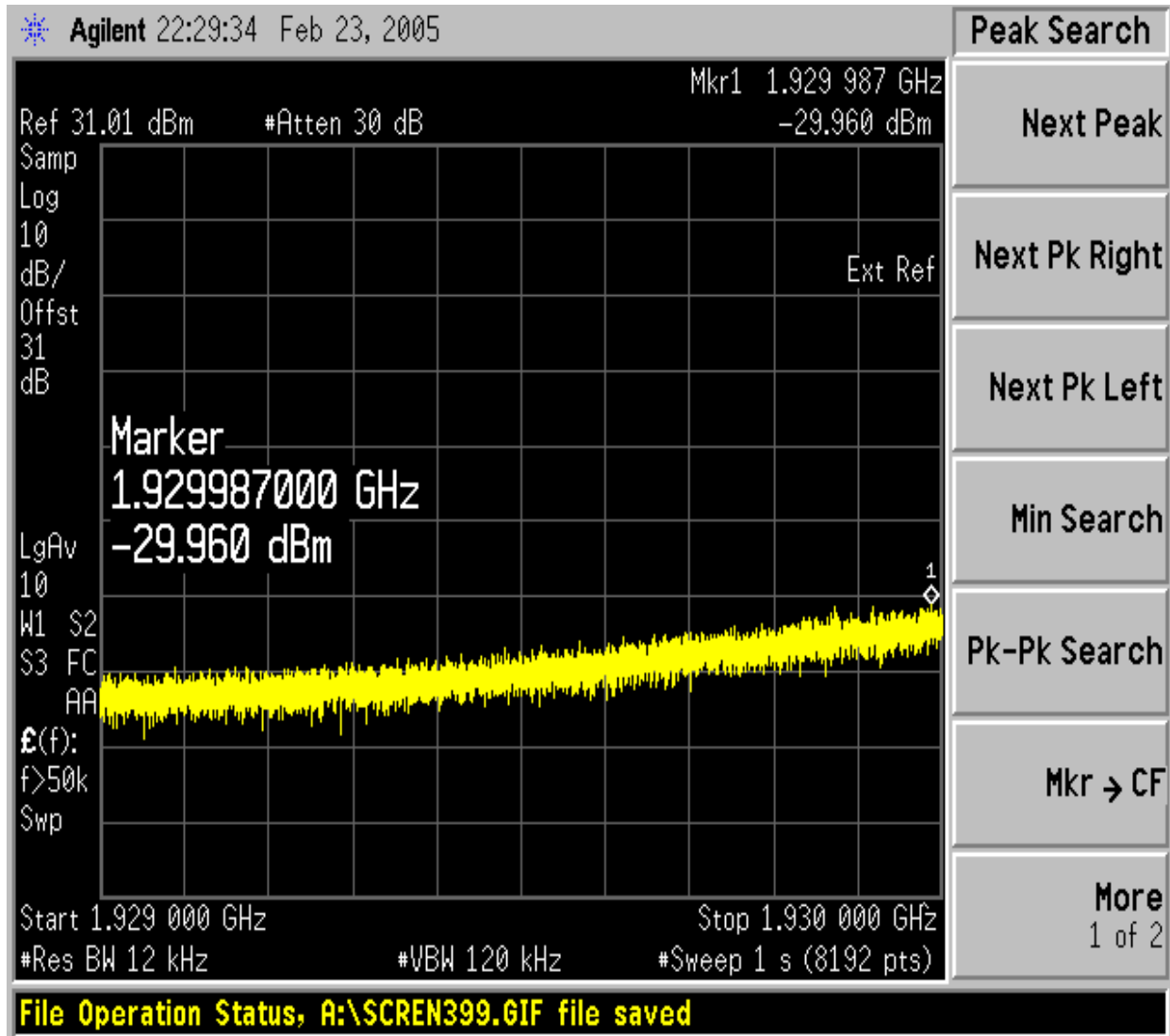
**Table 8 : Spurious Emissions at the 1900 MHz SFRM Radio Module DPM Antenna Port**

Channel Numbers (Band)	Frequency (MHz)	Worst Case Spurious Emissions Level (dBm)	Margin to FCC Limit of -13 dBm (dB)
25 (A)	1929 :- 1930 (lower adjacent MHz)	-29.96	16.96
	1950 :- 1951 (upper adjacent MHz)	-44.92	31.92
	9KHz - 1929 MHz	-30.77	17.77
	1951 MHz - 5 GHz	-27.31	14.31
	5 GHz - 20 GHz	-23.27	10.27
375 (D)	1929 :- 1930 (lower adjacent MHz)	-46.74	33.74
	1950 :- 1951 (upper adjacent MHz)	-27.34	14.34
	9KHz - 1929 MHz	-28.97	15.97
	1951 MHz - 5 GHz	-27.79	14.79
	5 GHz - 20 GHz	-24.51	11.51
425 (B)	1949 :- 1950 (lower adjacent MHz)	-30.21	17.21
	1970 :- 1971 (upper adjacent MHz)	-46.03	33.03
	9KHz - 1949 MHz	-30.52	17.52
	1971 MHz - 5 GHz	-27.10	14.10
	5 GHz - 20 GHz	-22.35	9.35
775 (E)	1949 :- 1950 (lower adjacent MHz)	-45.73	32.73
	1970 :- 1971 (upper adjacent MHz)	-26.33	13.33
	9KHz - 1949 MHz	-29.01	16.01
	1971 MHz - 5 GHz	-25.00	12.00
	5 GHz - 20 GHz	-21.64	8.64
825(F)	1969 :- 1970 (lower adjacent MHz)	-31.61	18.61
	1990 :- 1991 (upper adjacent MHz)	-47.61	34.61
	9KHz - 1969 MHz	-33.40	20.4
	1991 MHz - 5 GHz	-26.87	13.87
	5 GHz - 20 GHz	-23.16	10.16

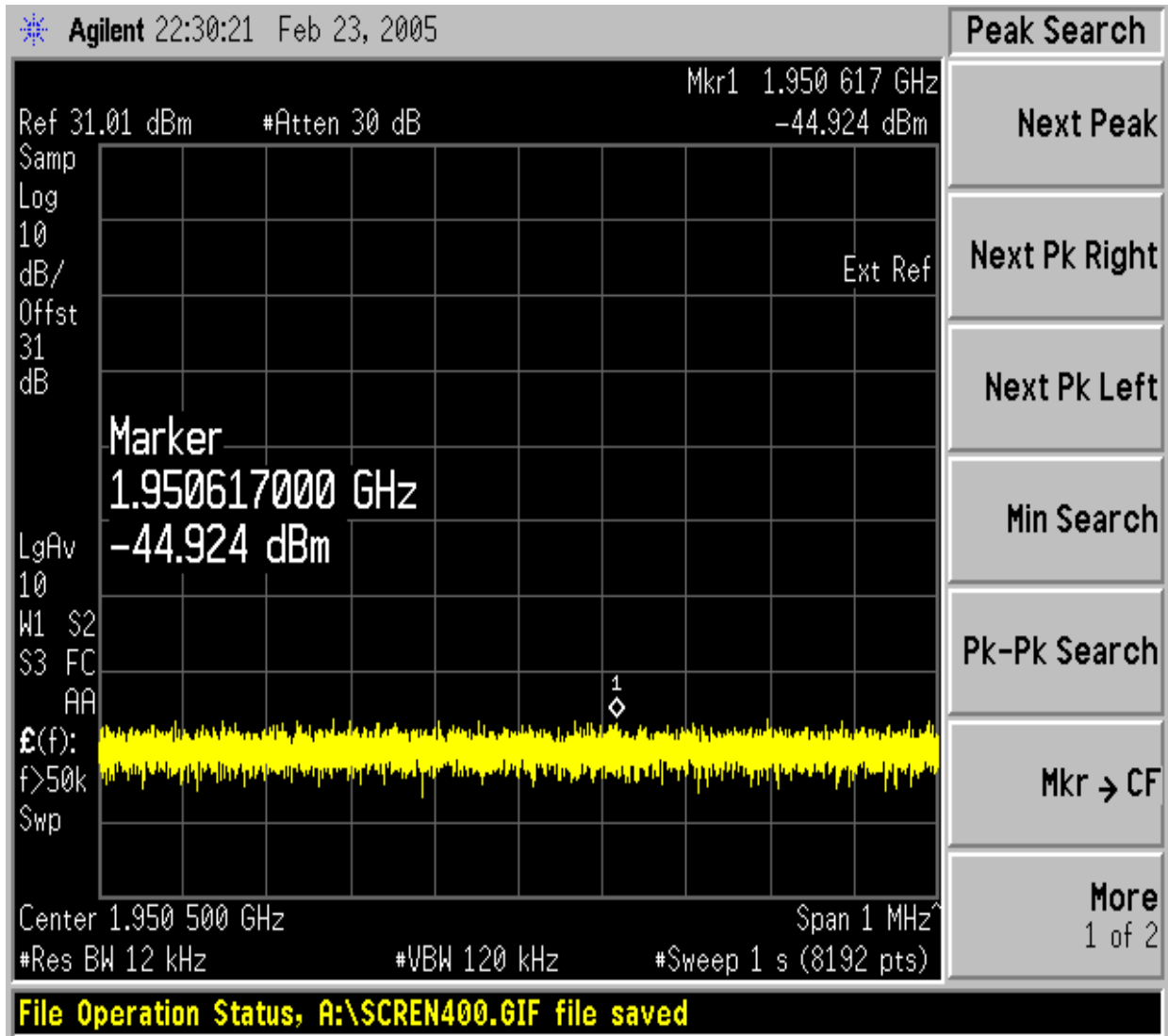
Channel Numbers (Band)	Frequency (MHz)	Worst Case Spurious Emissions Level (dBm)	Margin to FCC Limit of -13 dBm (dB)
1175 (C)	1969 -:- 1970 (lower adjacent MHz)	-43.65	30.65
	1990 -:- 1991 (upper adjacent MHz)	-26.75	13.75
	9KHz - 1969 MHz	-26.65	13.65
	1991 MHz - 5 GHz	-25.00	12.00
	5 GHz - 20 GHz	-21.58	8.58



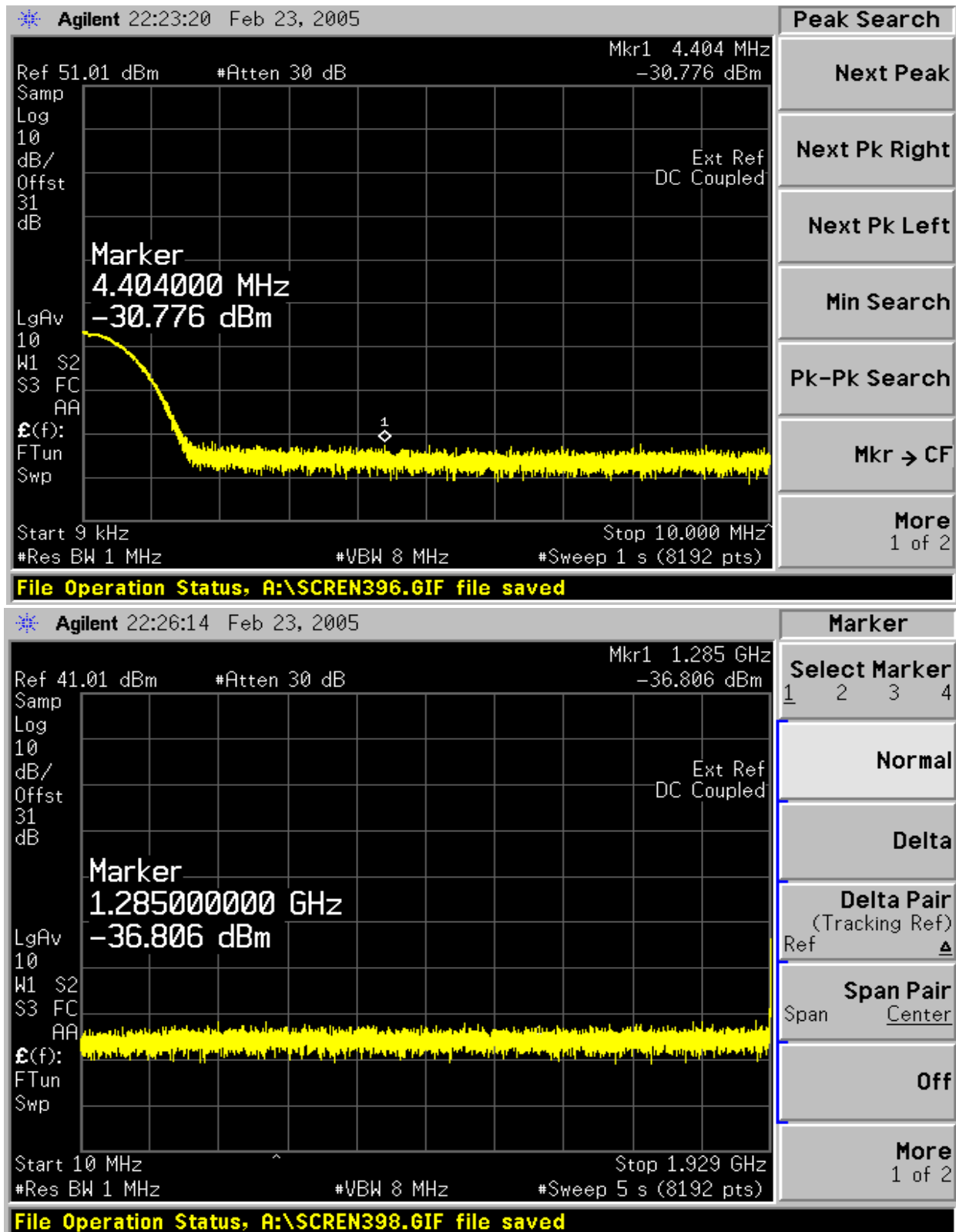
**Figure 10 : Conducted Spurious Emissions - Channel 25 (Lower adjacent 1 MHz)**



**Figure 11 : Conducted Spurious Emissions - Channel 25 (Upper Adjacent 1 MHz)**



**Figure 12 : Conducted Spurious Emissions - Channel 25 (9kHz :- Lower Adjacent 1 MHz)**



**Figure 13 : Conducted Spurious Emissions - Channel 25, (Upper Adjacent 1 MHz to 5GHz)**

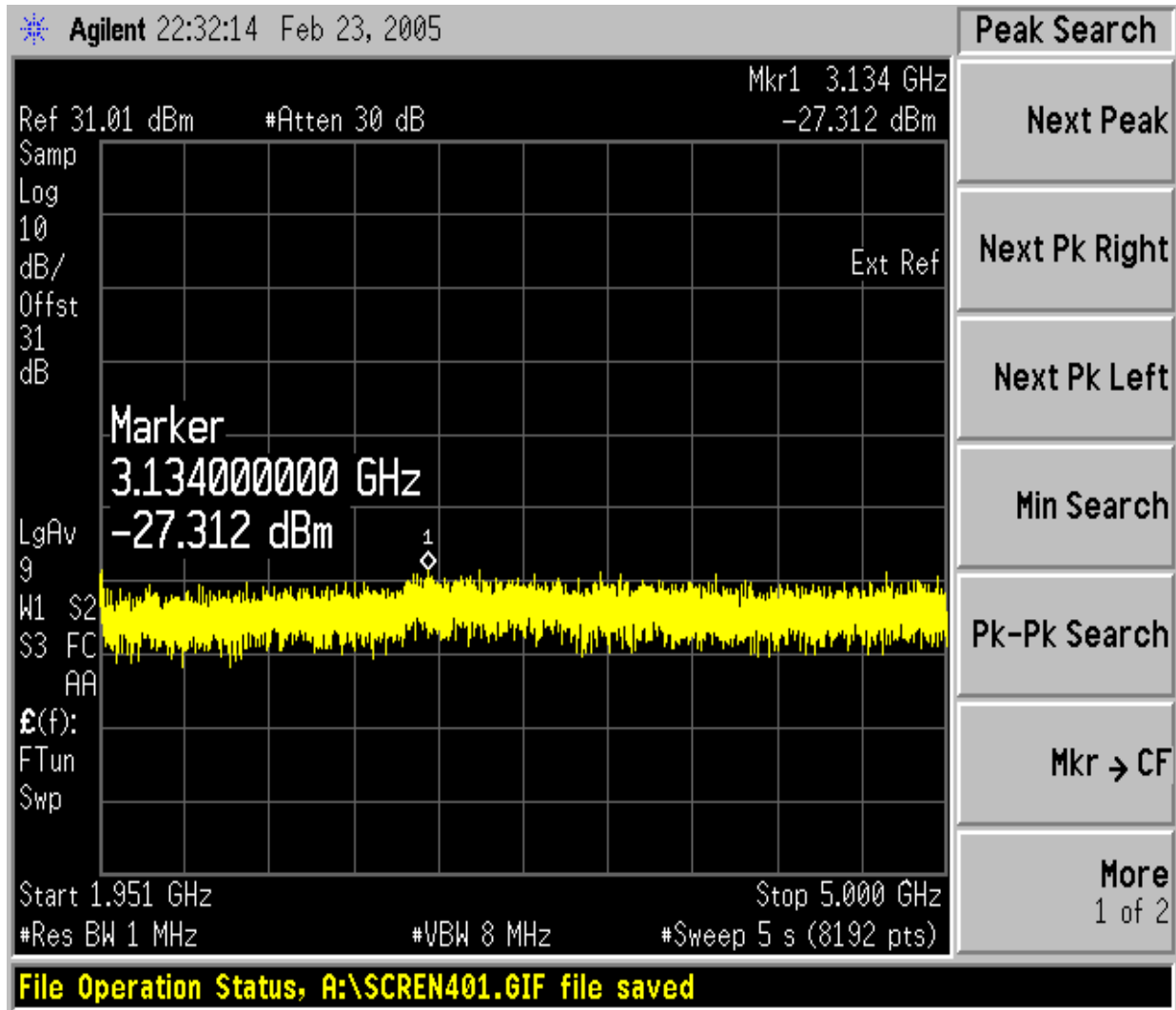
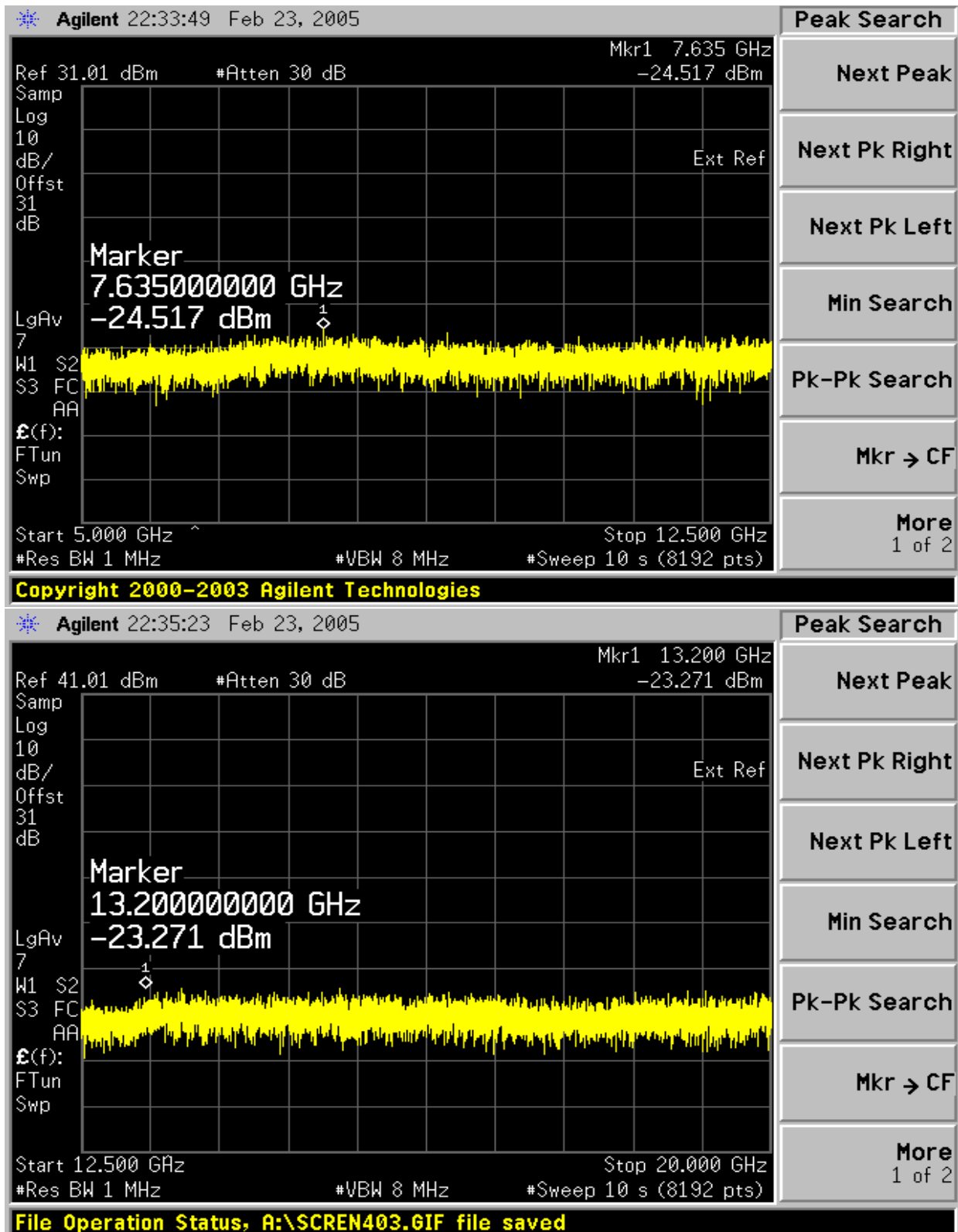


Figure 14 : Conducted Spurious Emissions - Channel 25 (5 GHz :- 20G GHz)



**Figure 15 : Conducted Spurious Emissions - Channel 375, Lower Adjacent 1MHz**

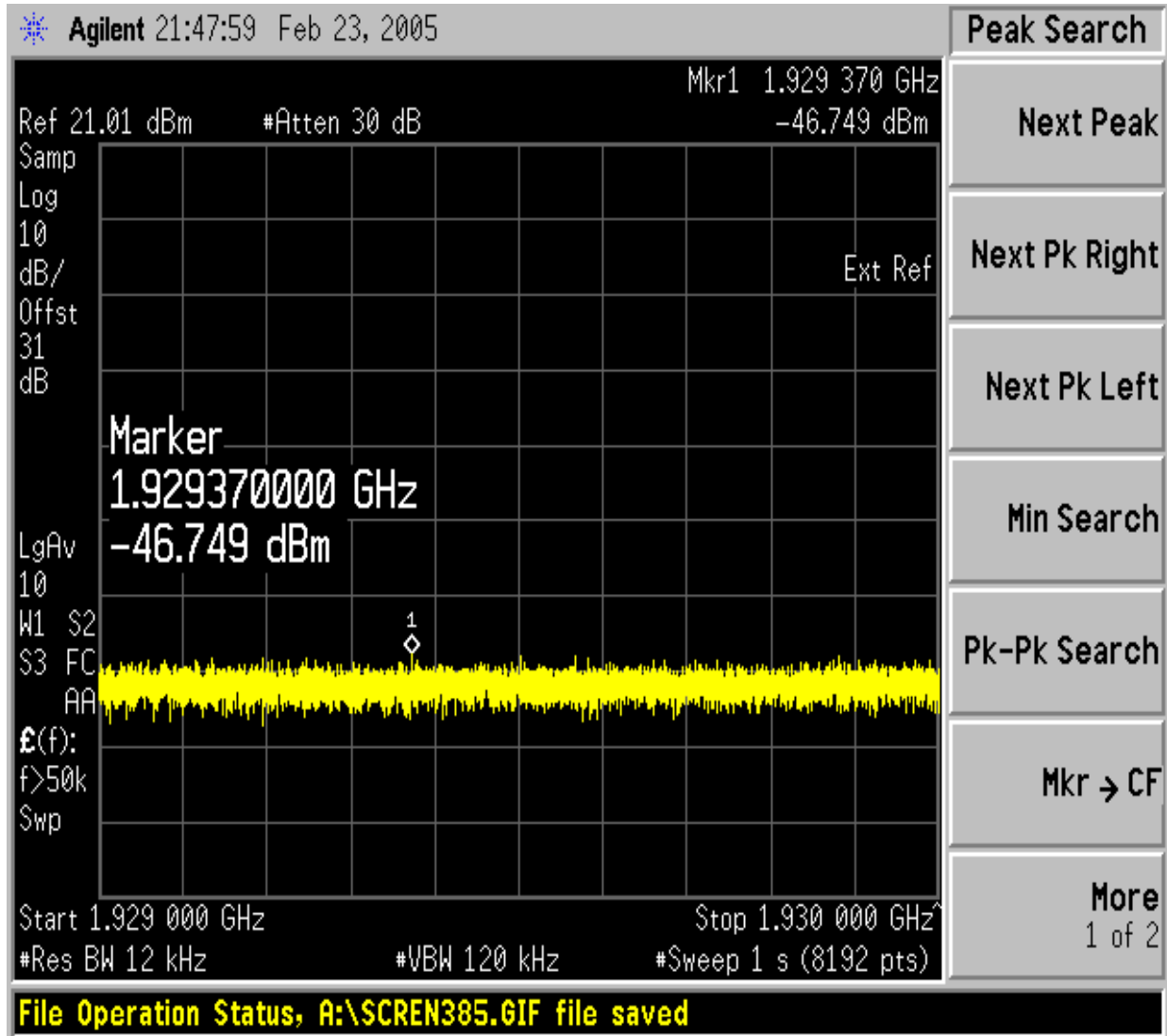
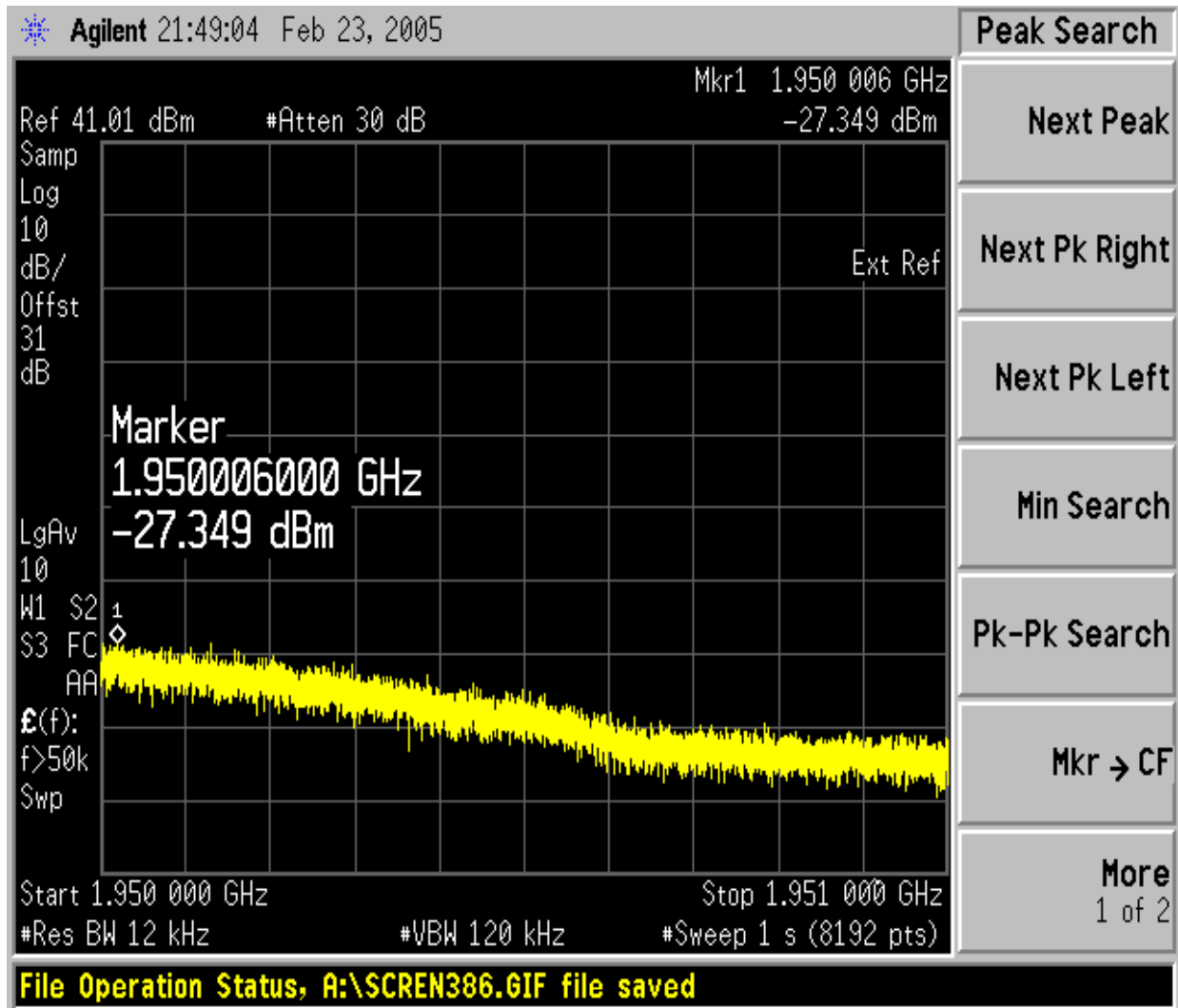
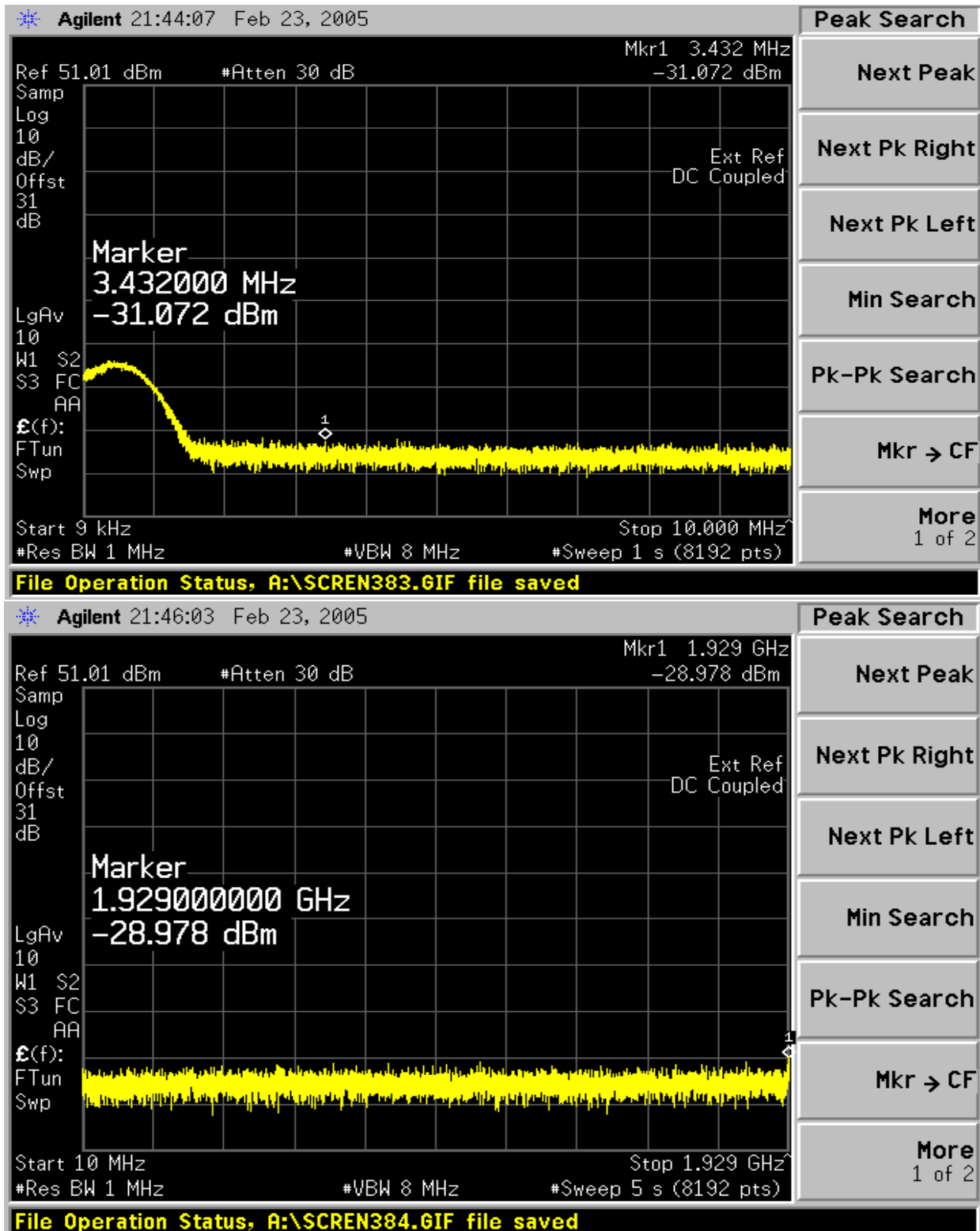


Figure 16 : Conducted Spurious Emissions - Channel 375, IS-85 (Higher Adjacent 1 MHz)

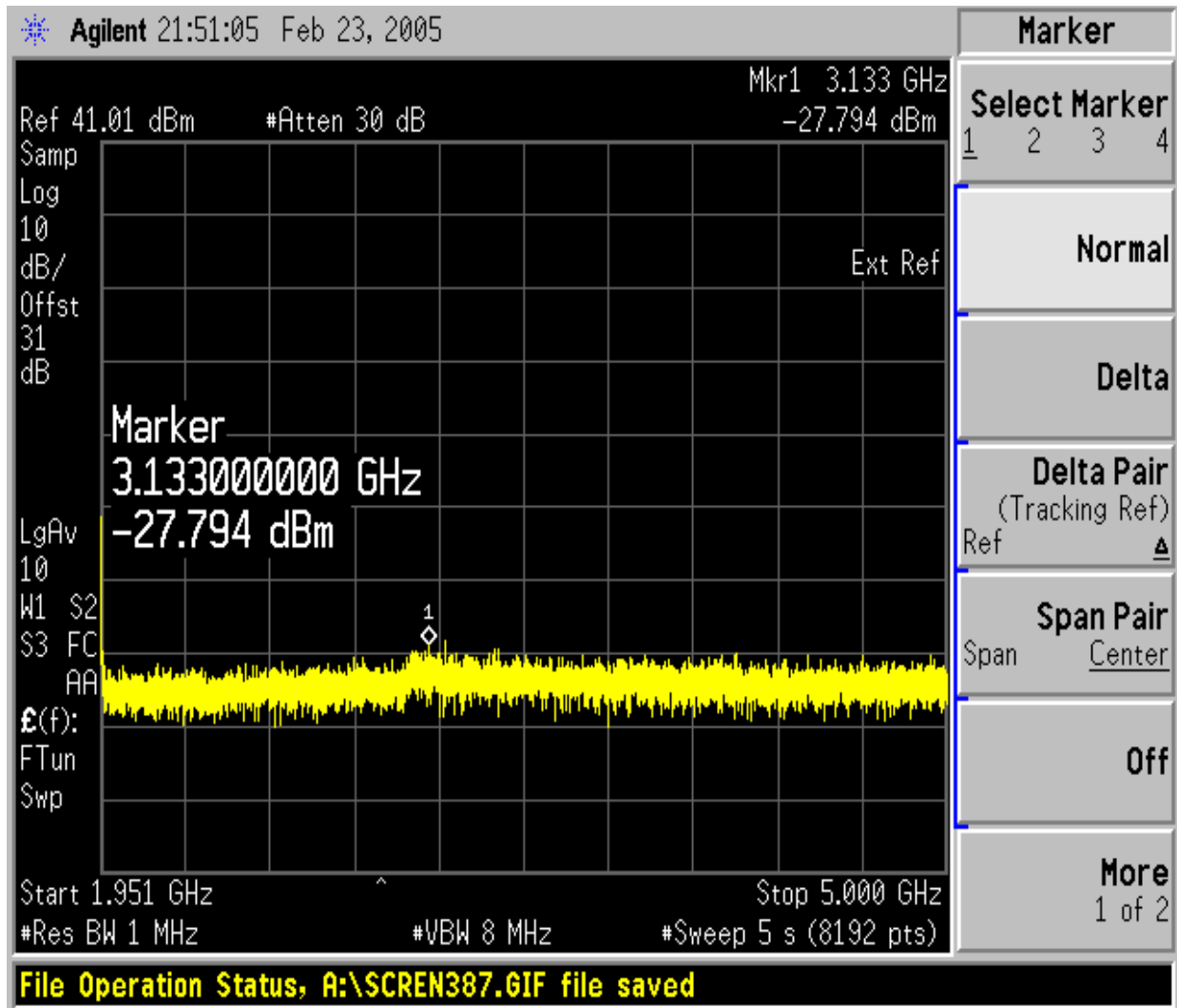


**Figure 17 : Conducted Spurious Emissions - Channel 375, IS-856 (9 KHz to Lower Adjacent 1 MHz)**

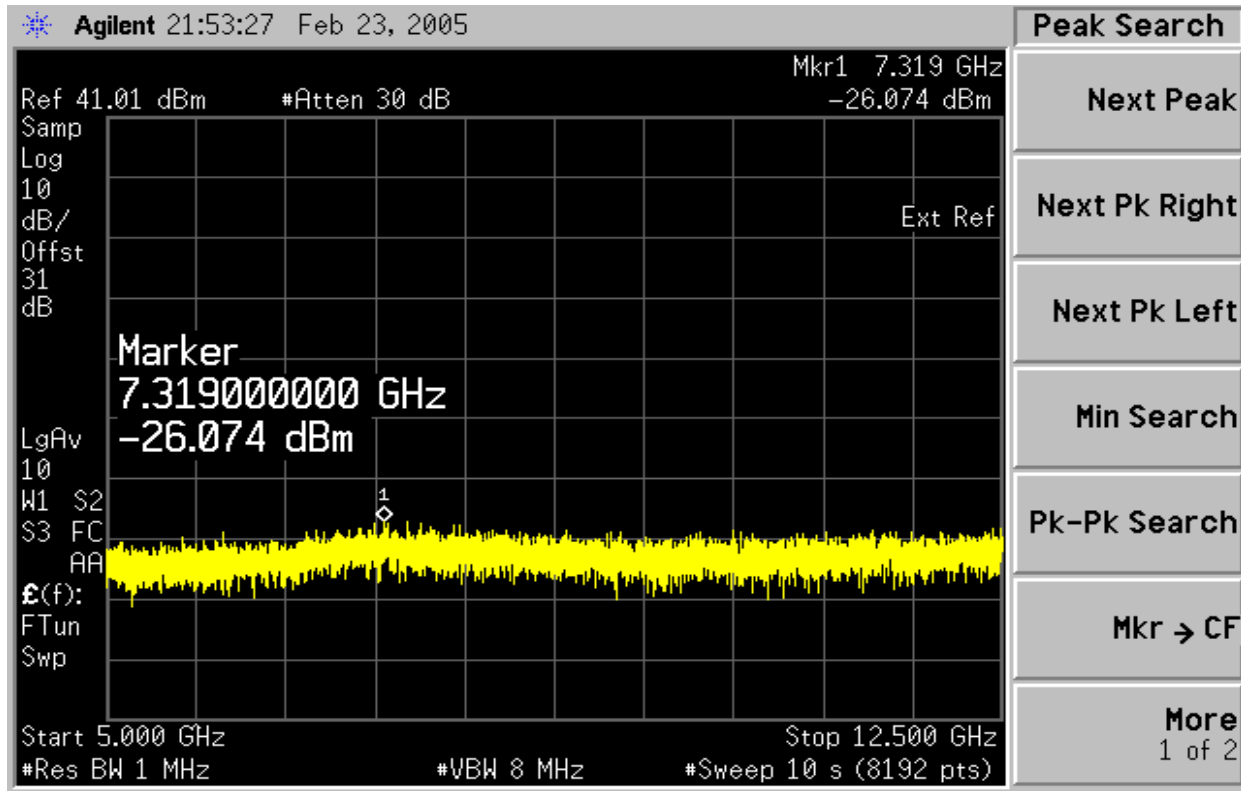




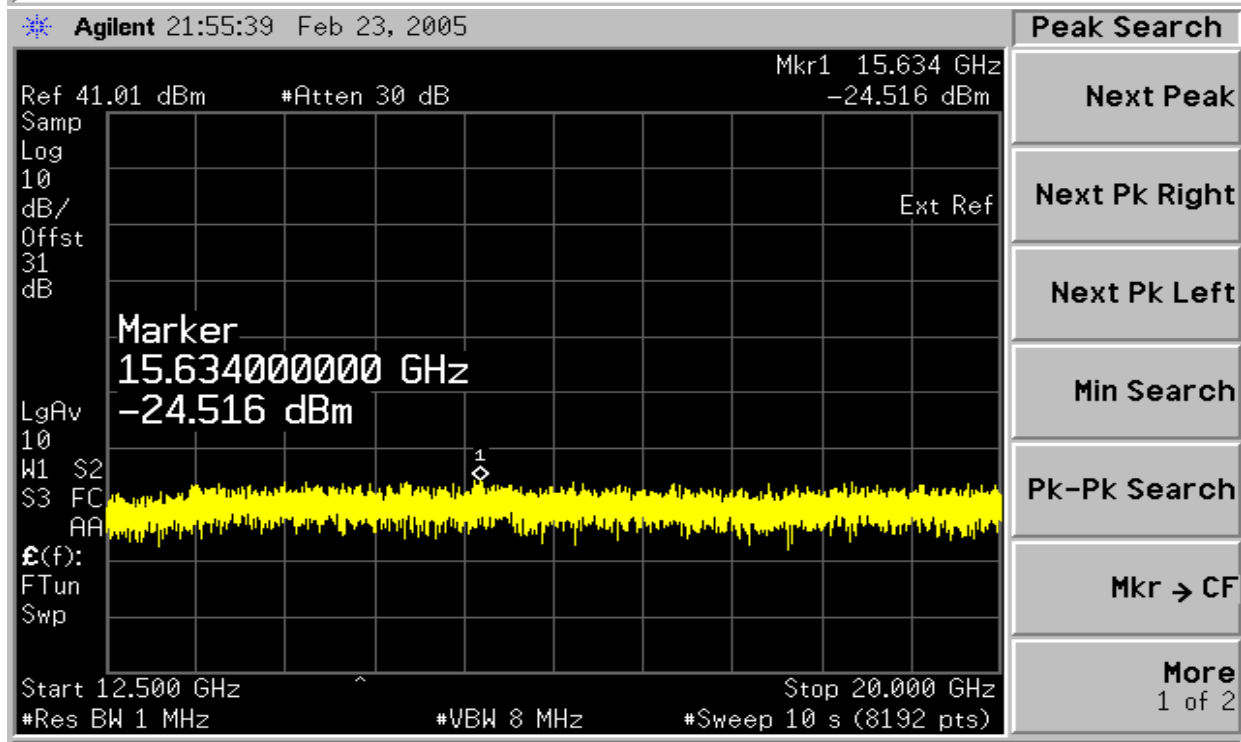
**Figure 18 : Conducted Spurious Emissions - Channel 375 (Higher Adjacent 1 MHz to 5GHz)**



**Figure 19 : Conducted Spurious Emissions - Channel 375 (5 GHz to 20 GHz)**



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Figure 20 : Conducted Spurious Emissions - Channel 425 (Lower Adjacent 1 MHz)

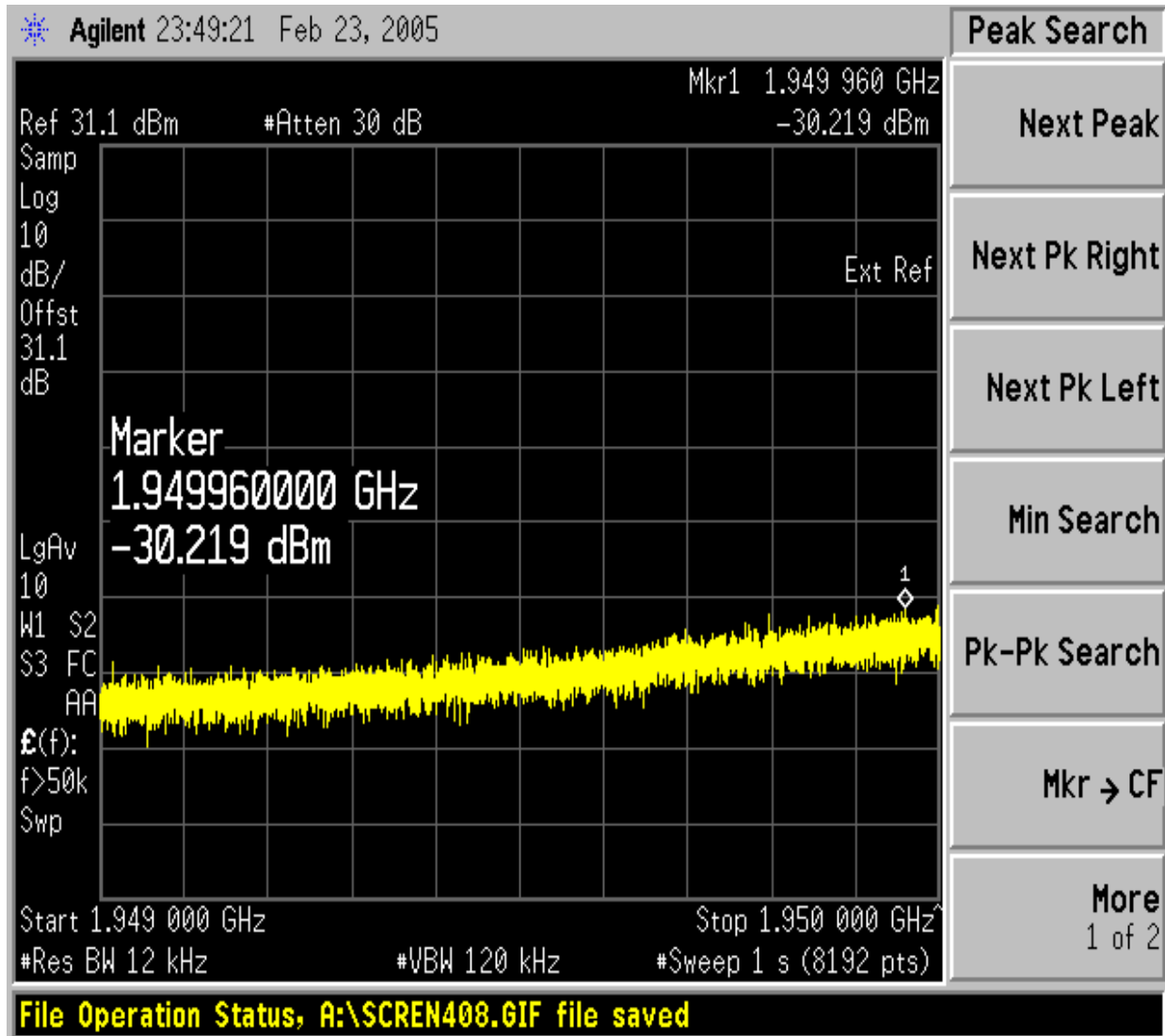
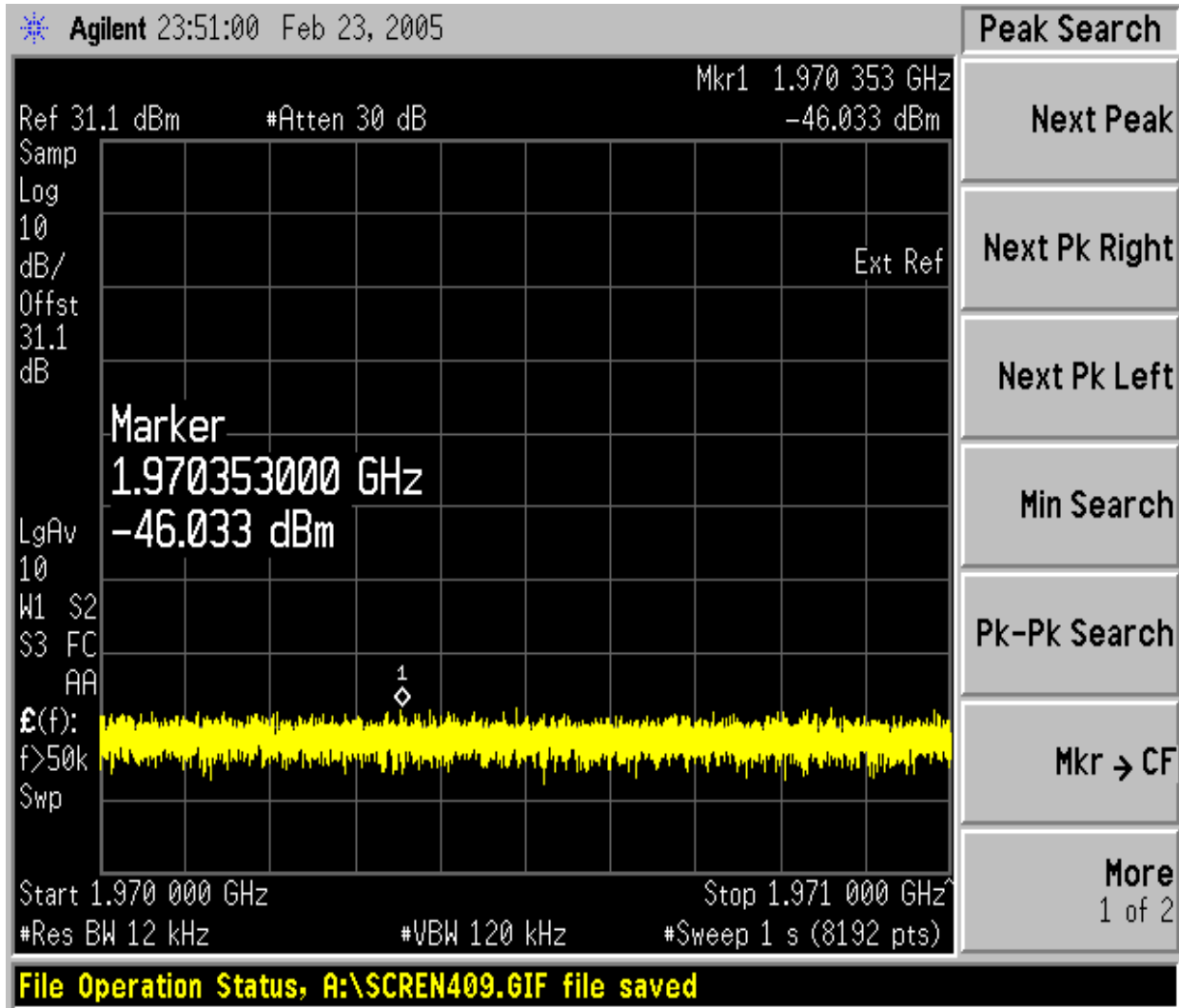
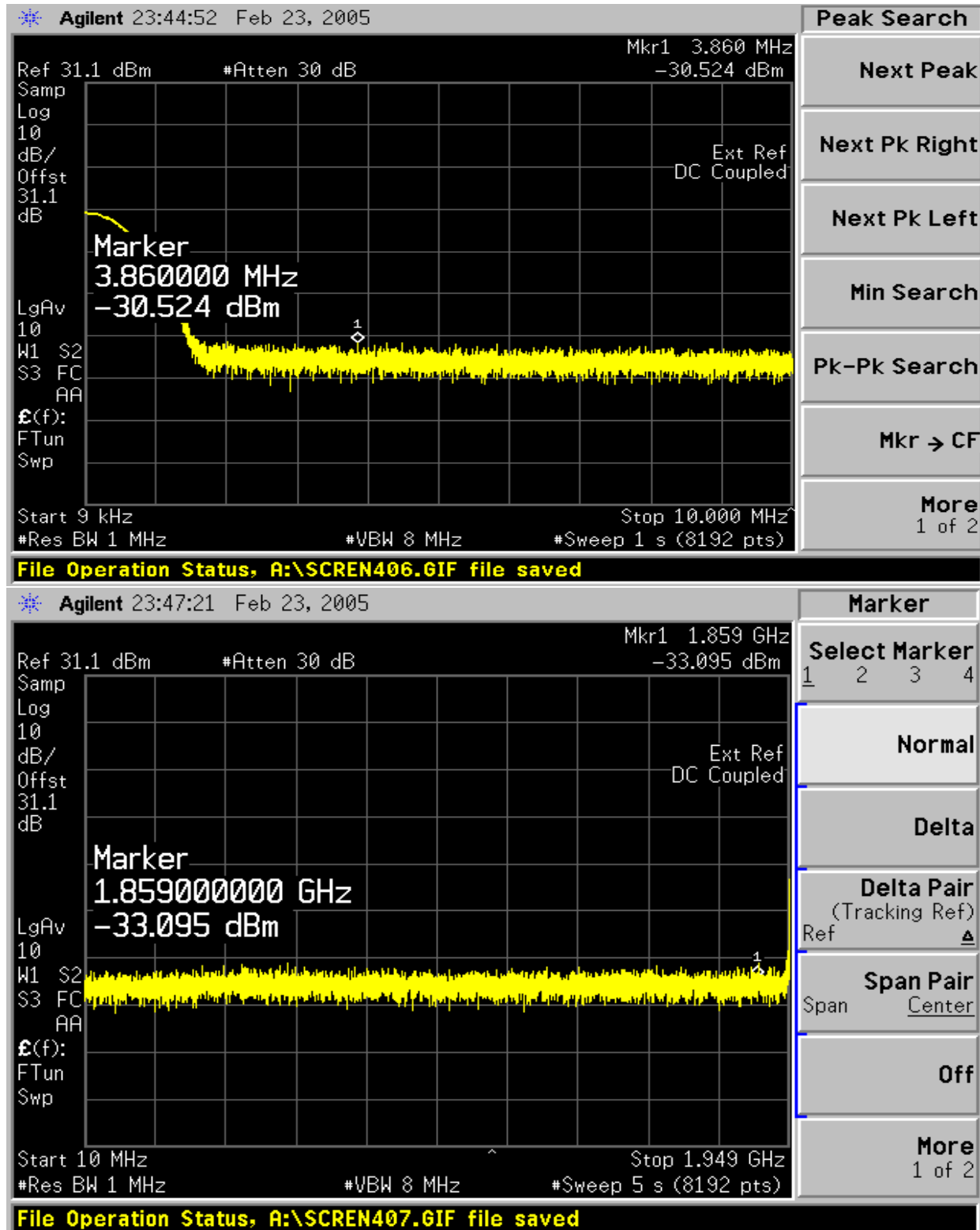


Figure 21 : Conducted Spurious Emissions - Channel 425 (Upper Adjacent 1 MHz)



**Figure 22 : Conducted Spurious Emissions - Channel 425 (9 KHz to Lower Adjacent 1MHz)**



**Figure 23 : Conducted Spurious Emissions - Channel 425 (Upper 1MHz to 5 GHz)**

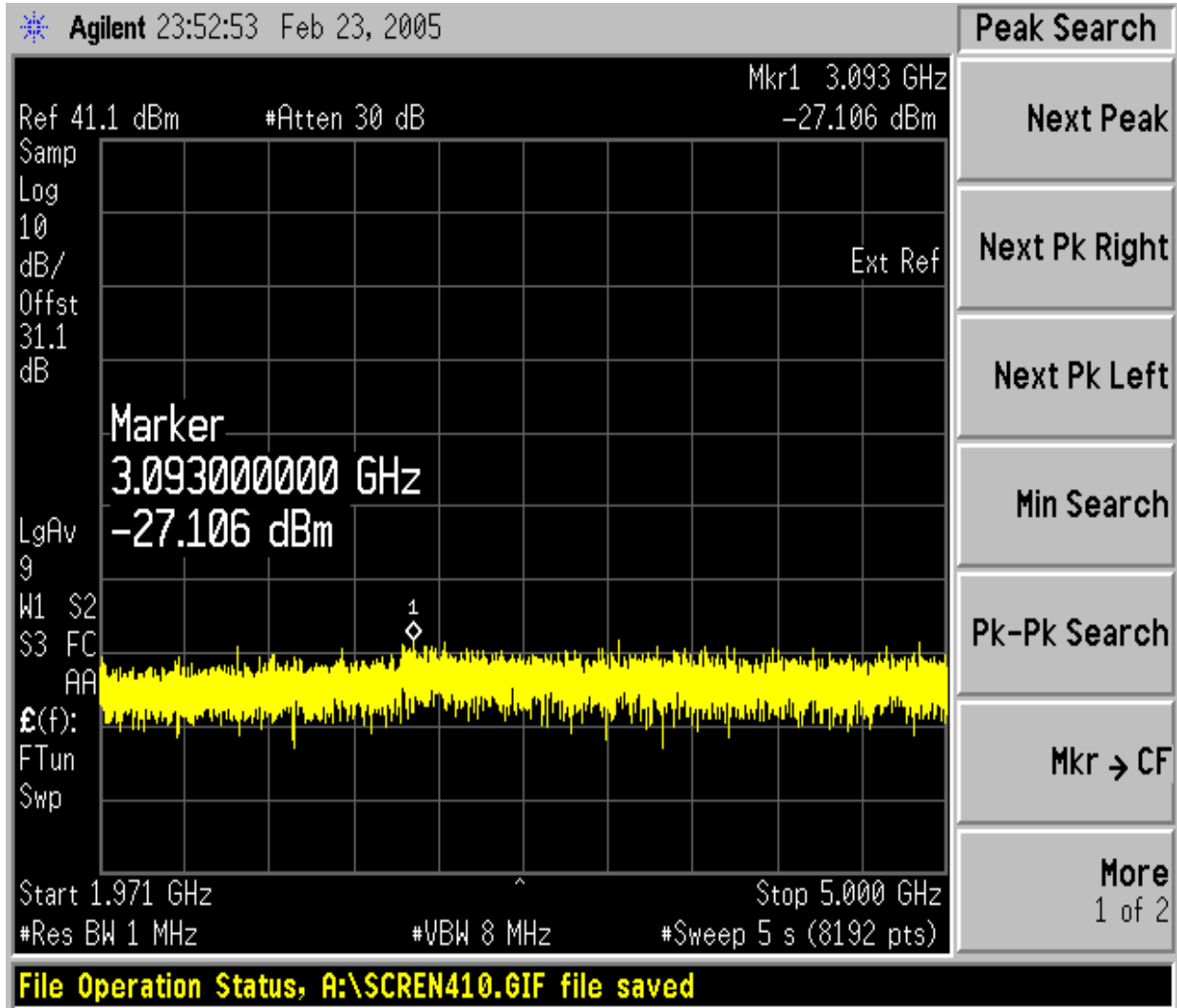
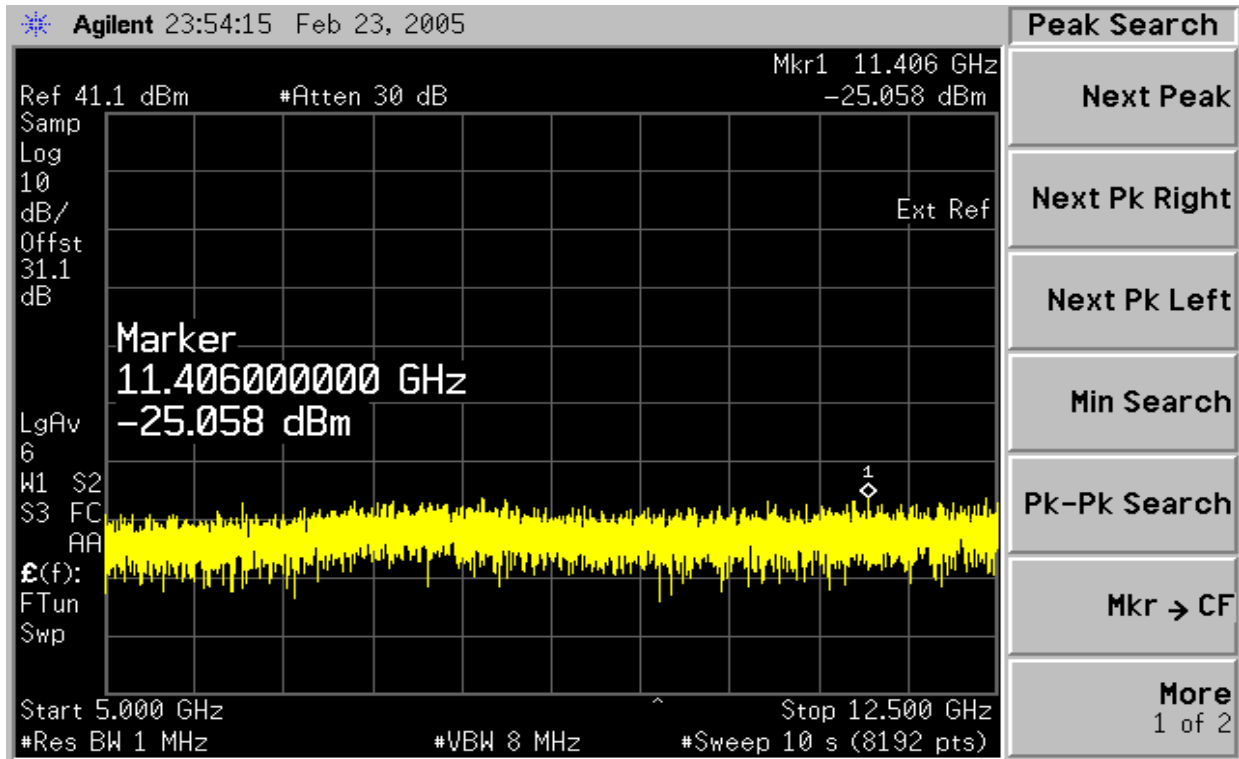
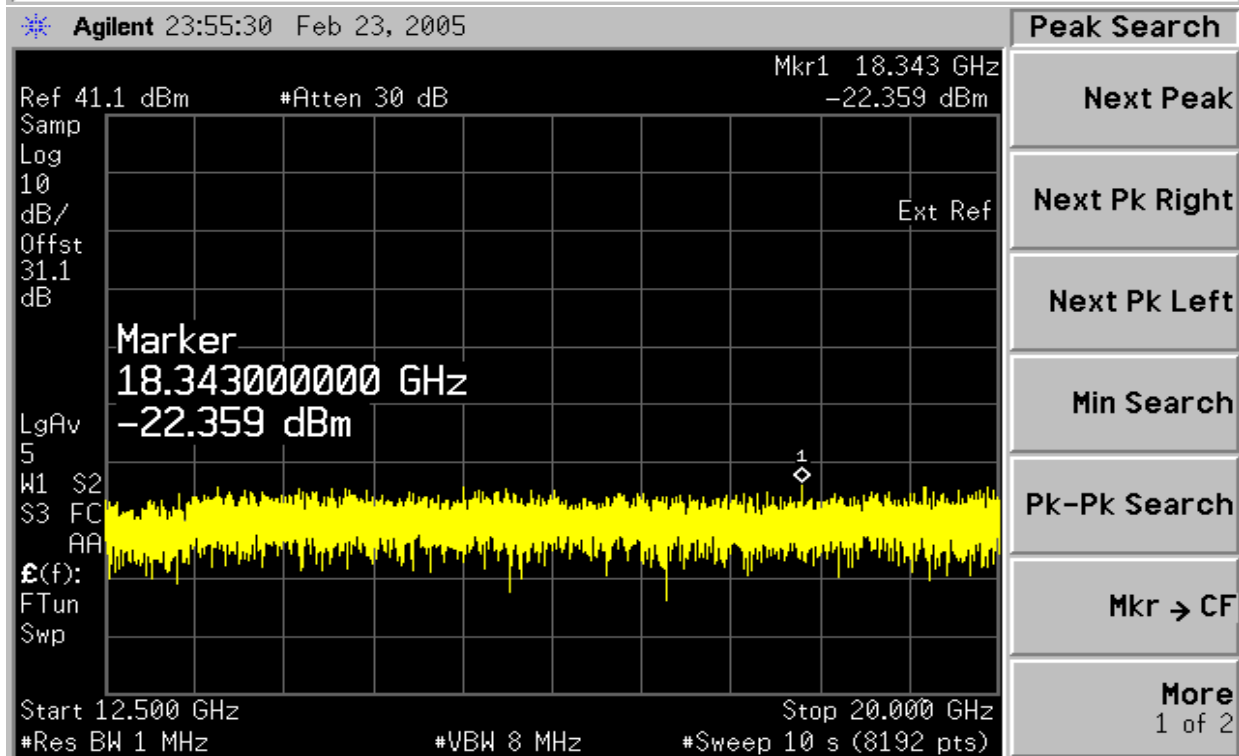


Figure 24 : Conducted Spurious Emissions - Channel 425 (5 GHz to 20 GHz)

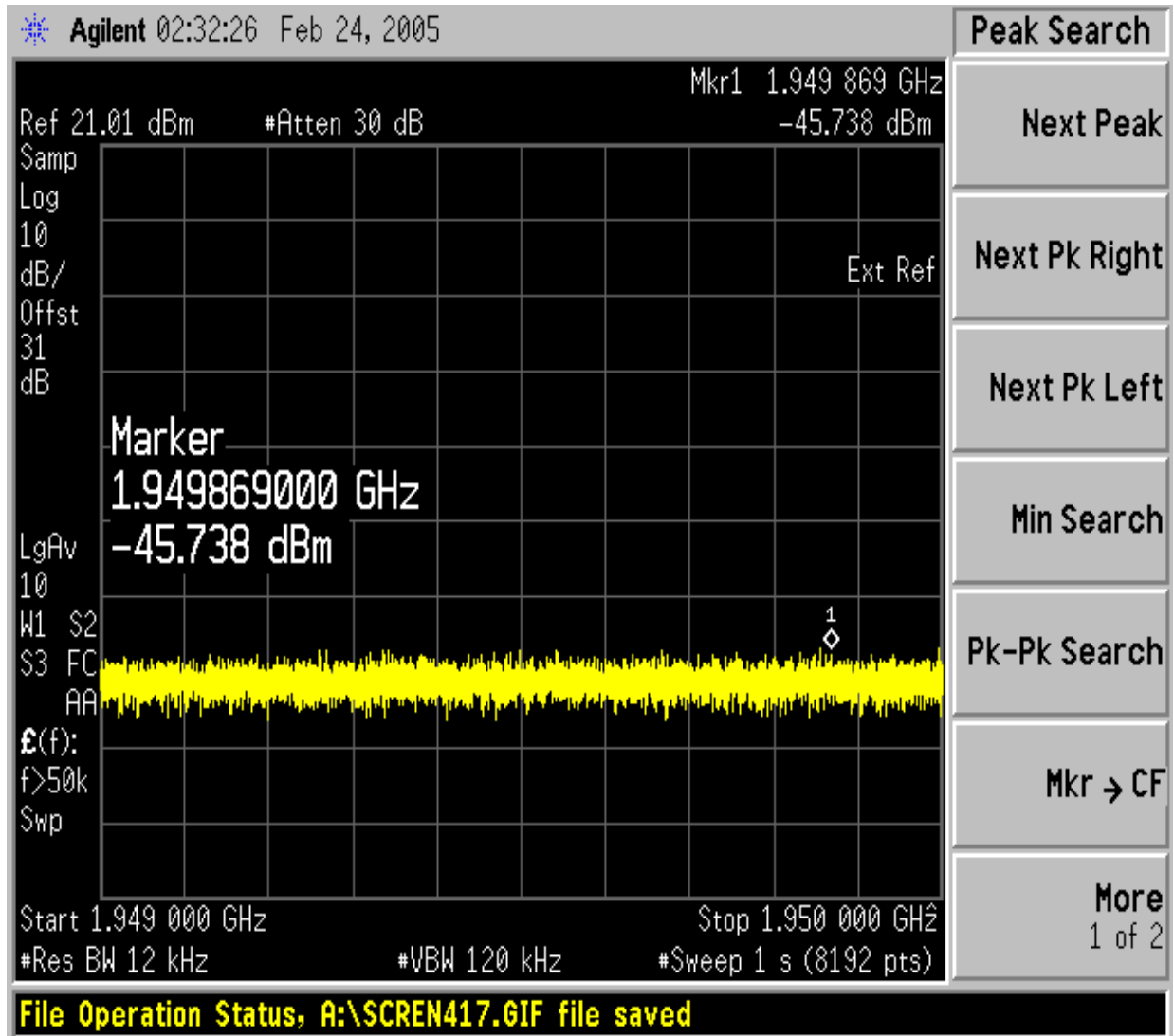


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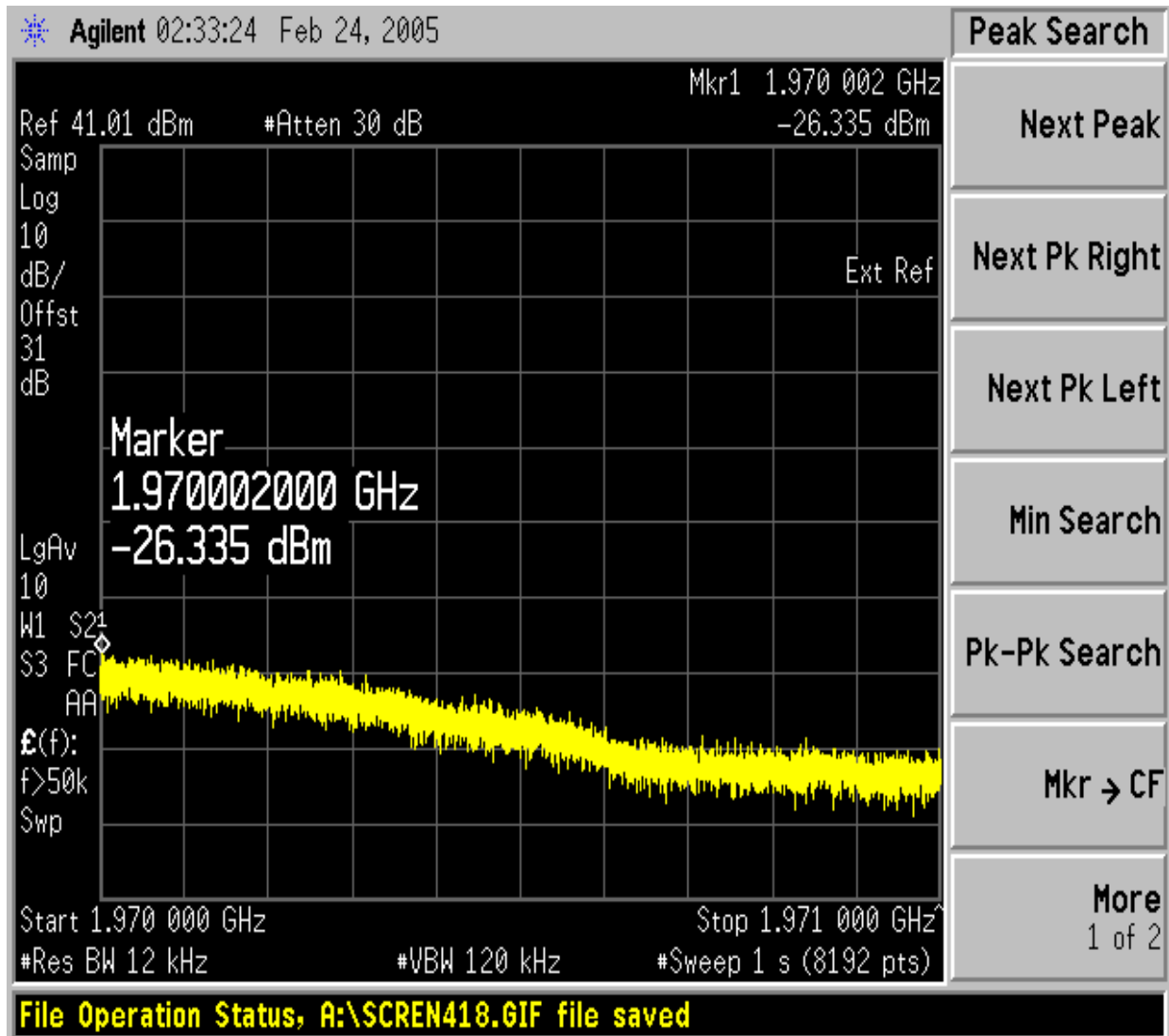
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**Figure 25 : Conducted Spurious Emissions - Channels 775 (Lower Adjacent 1 MHz)**

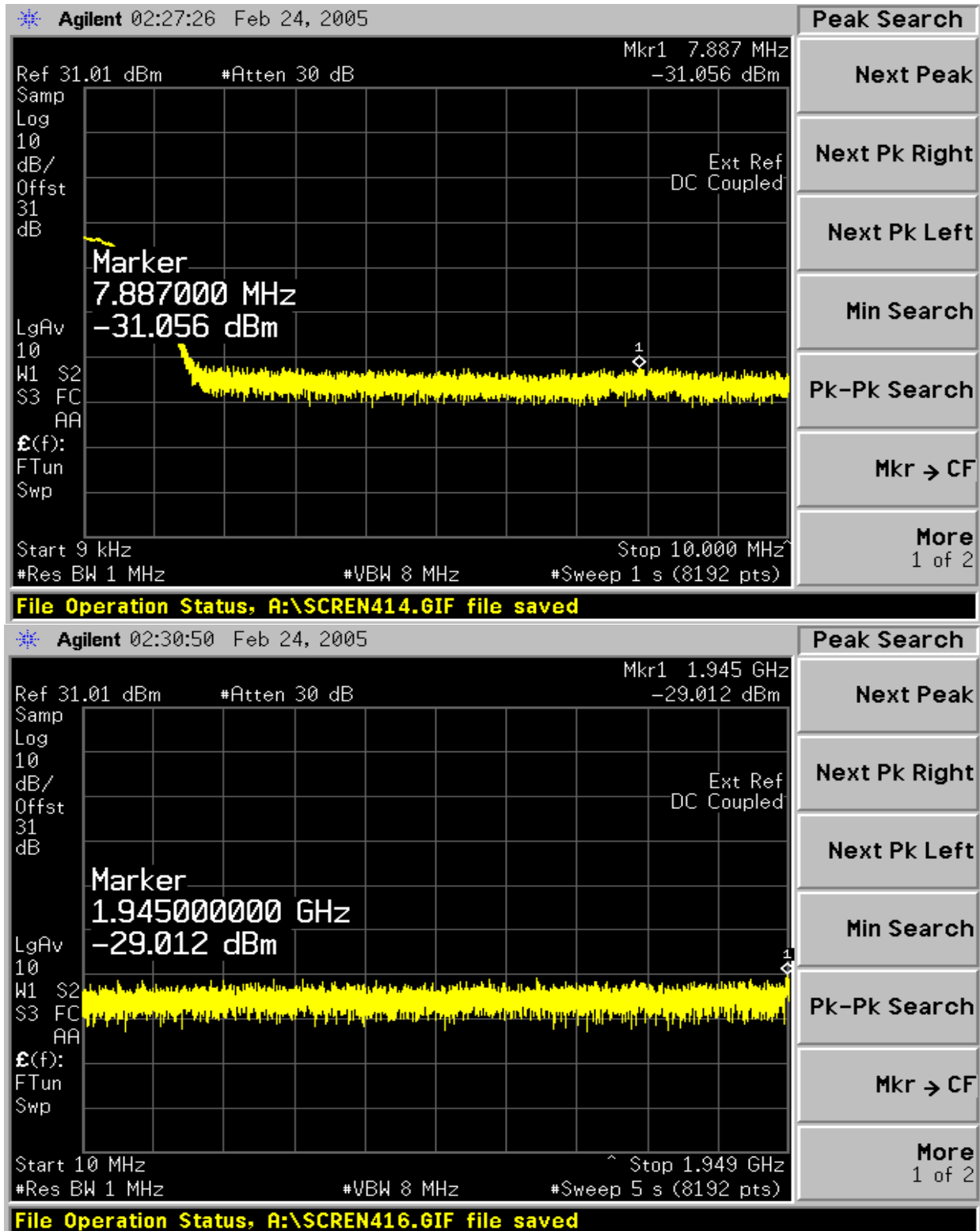




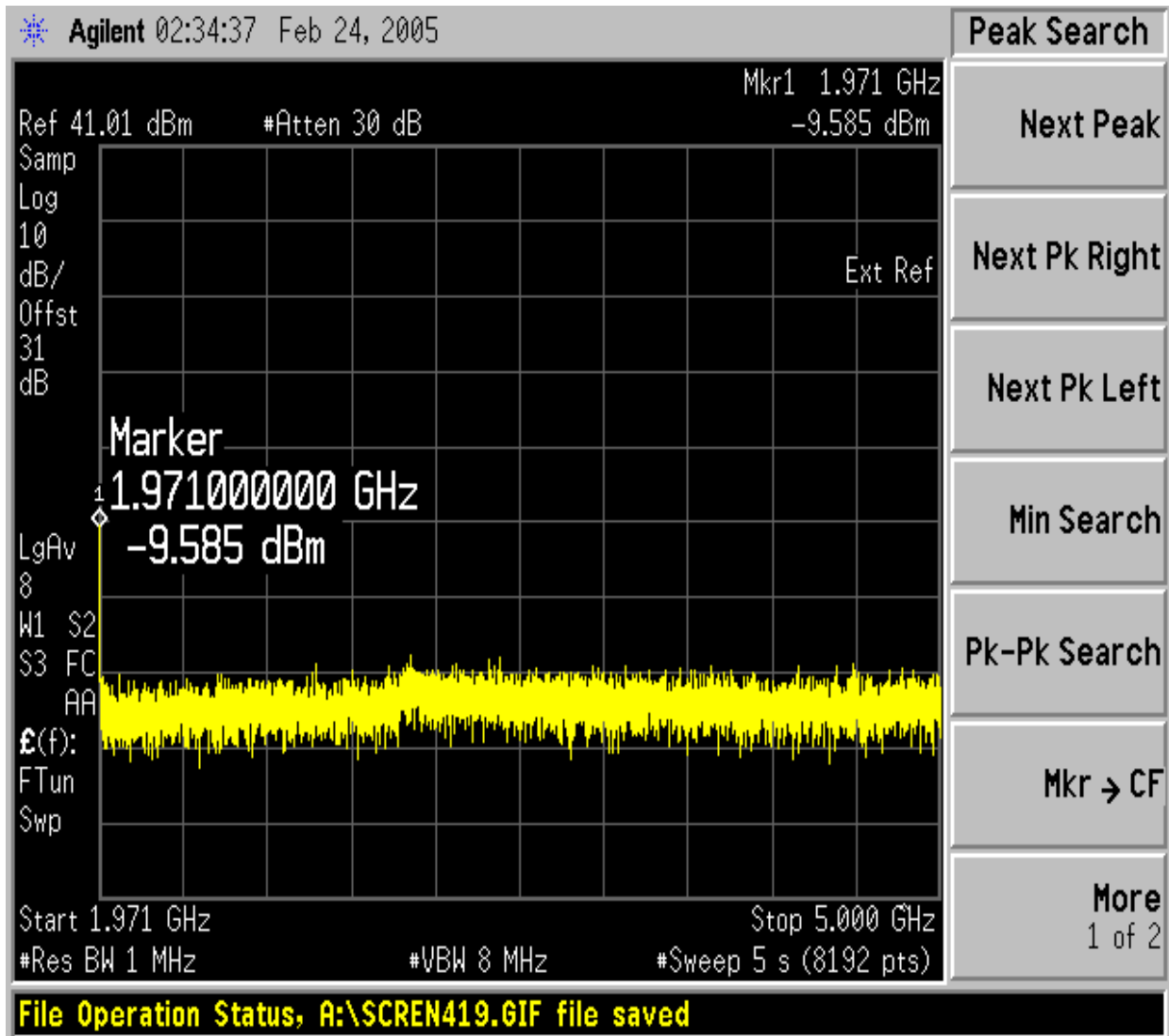
**Figure 26 : Conducted Spurious Emissions - Channels 775 (Upper Adjacent 1 MHz)**



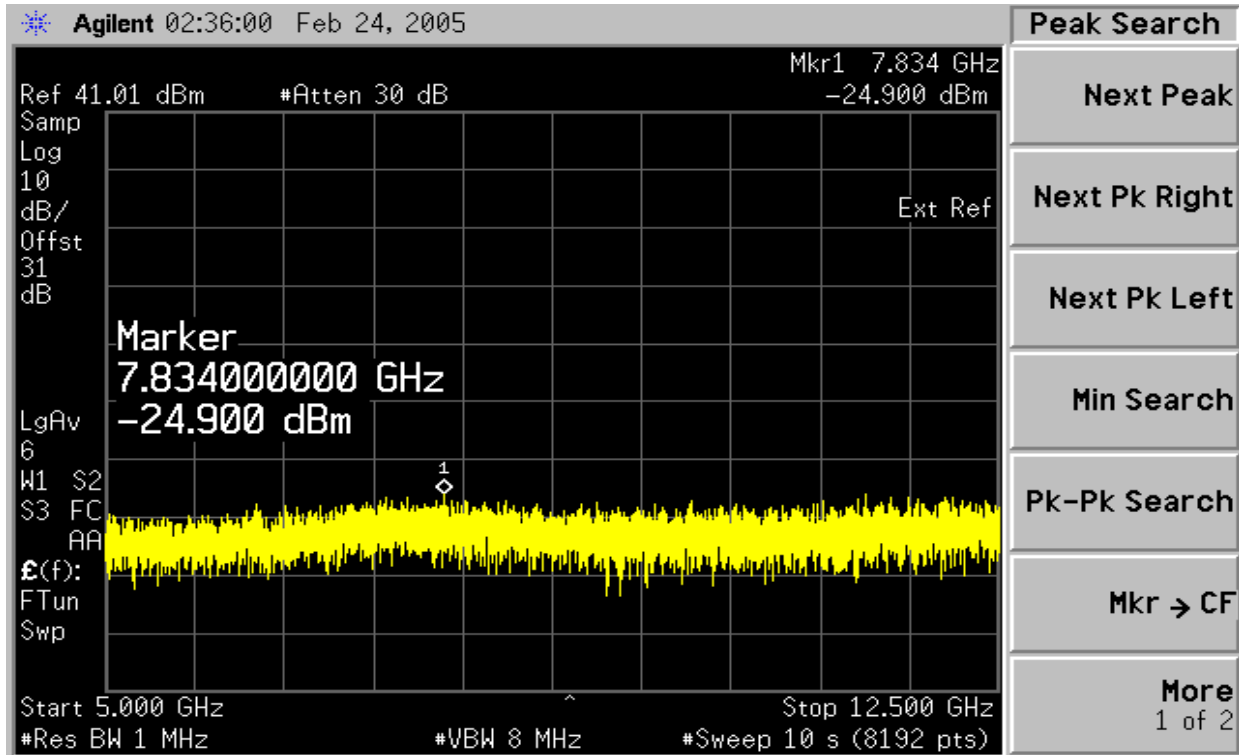
**Figure 27 : Conducted Spurious Emissions - Channel 775 (9 KHz to Lower Adjacent 1 MHz)**



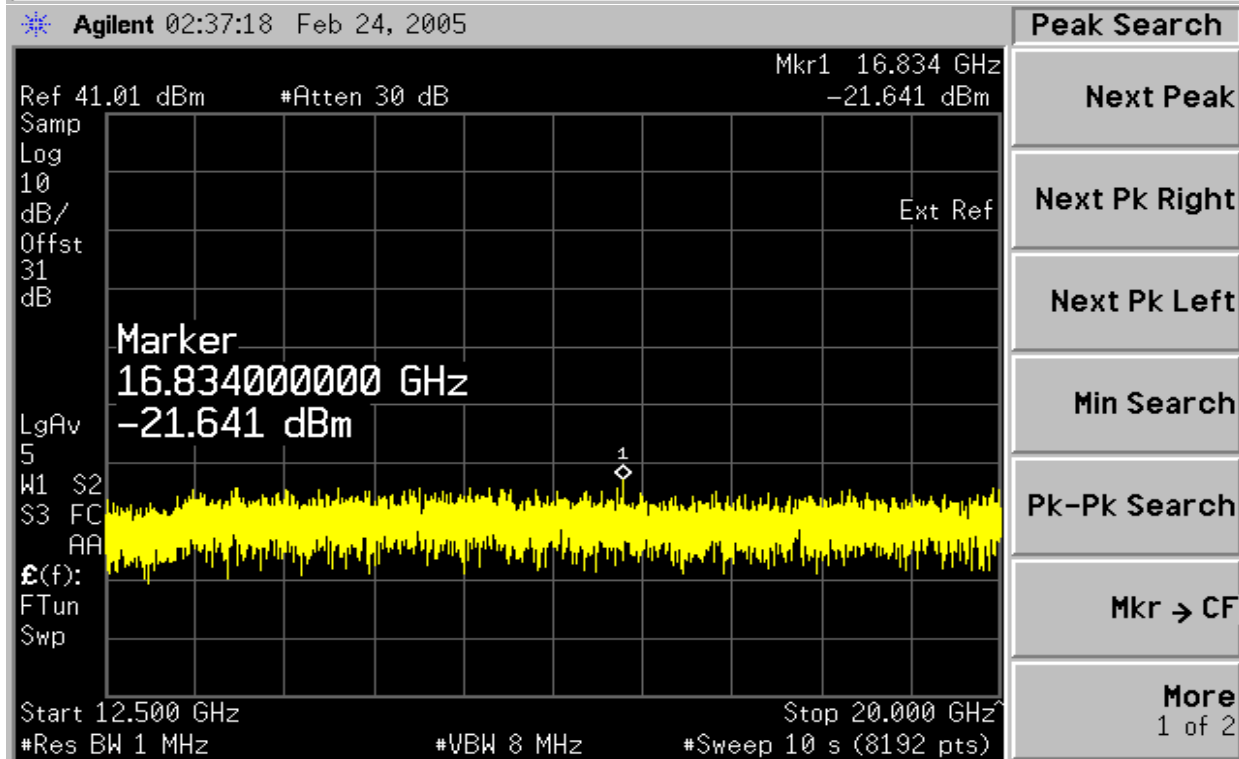
**Figure 28 : Conducted Spurious Emissions - Channel 775 (Upper Adjacent 1 MHz to 5 GHz)**



**Figure 29 : Conducted Spurious Emissions - Channels 775 (5 GHz to 20 GHz)**

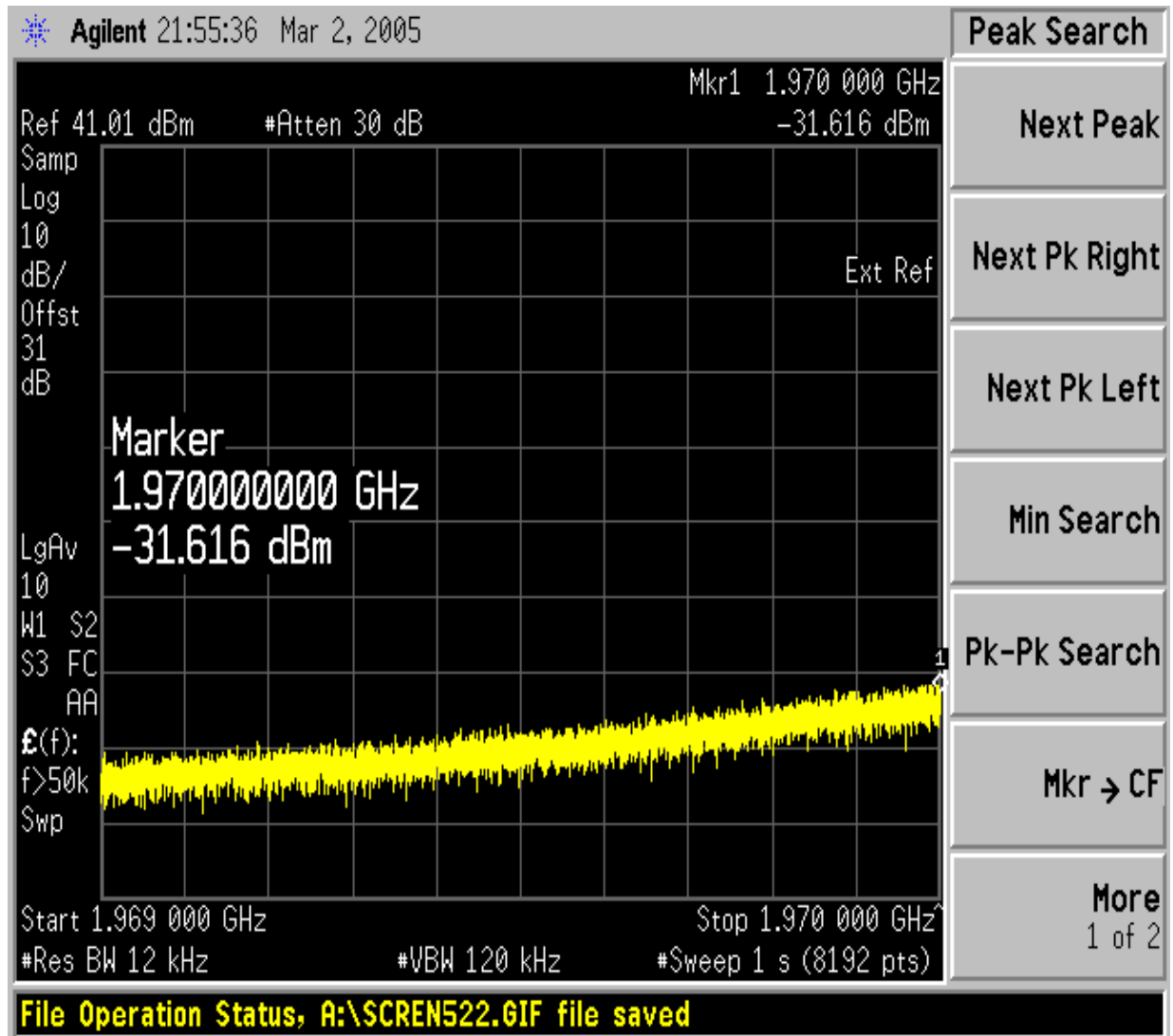


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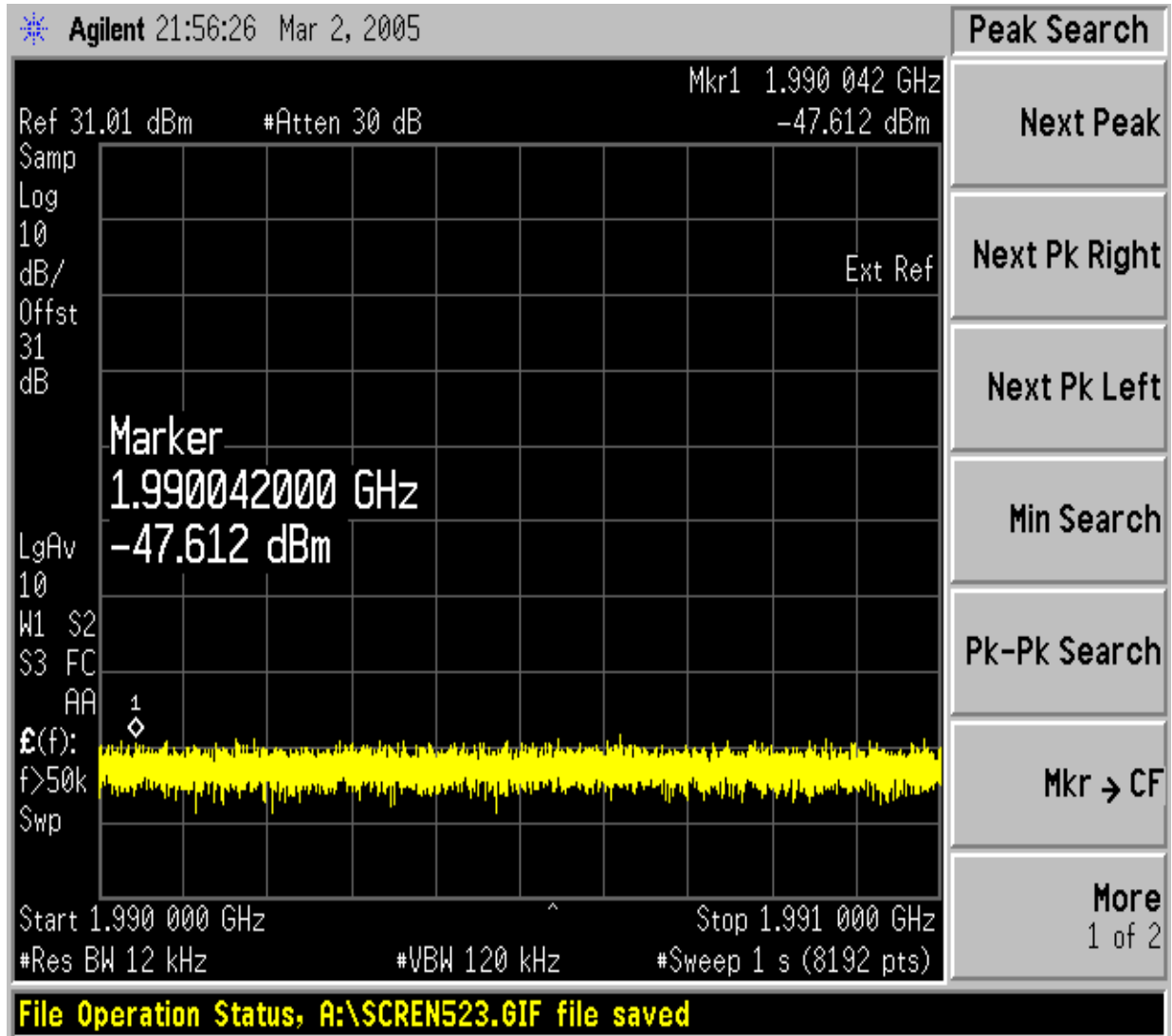


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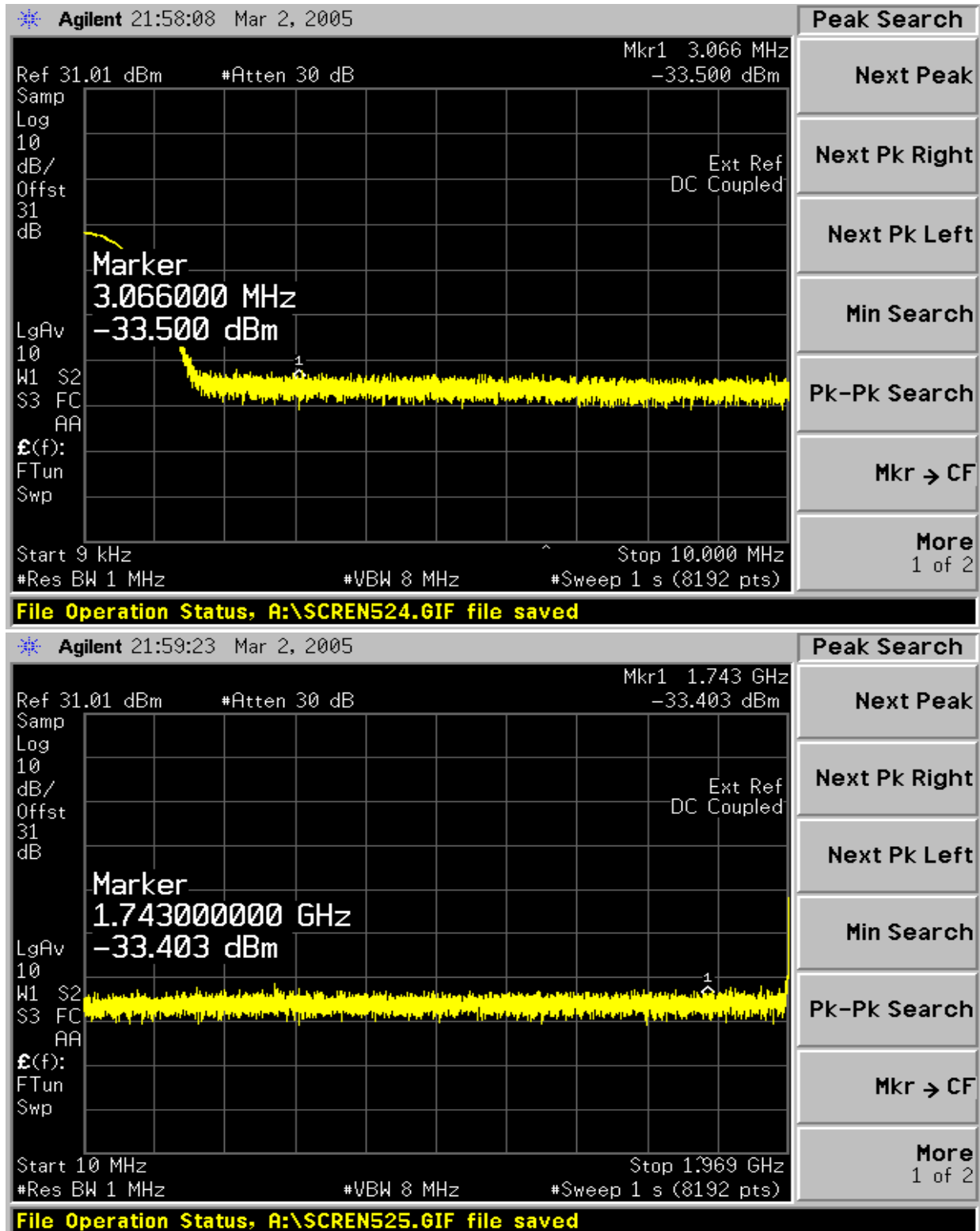
**Figure 30 : Conducted Spurious Emissions - Channel 825 (Lower Adjacent 1 MHz)**



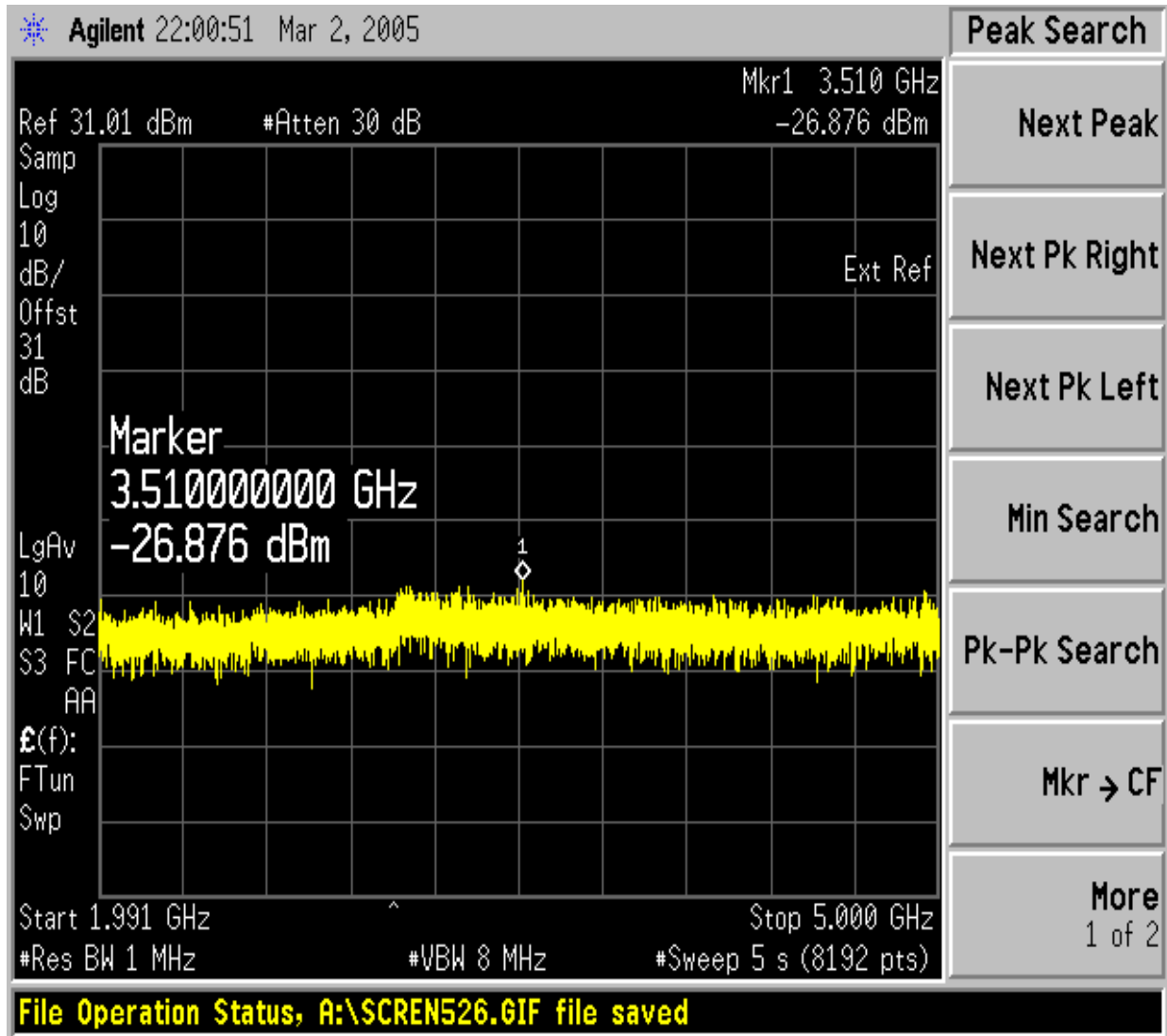
**Figure 31 : Conducted Spurious Emissions - Channel 825 (Upper Adjacent 1 MHz)**



**Figure 32 : Conducted Spurious Emissions - Channel 825( 9 KHz to Lower Adjacent 1 MHz)**

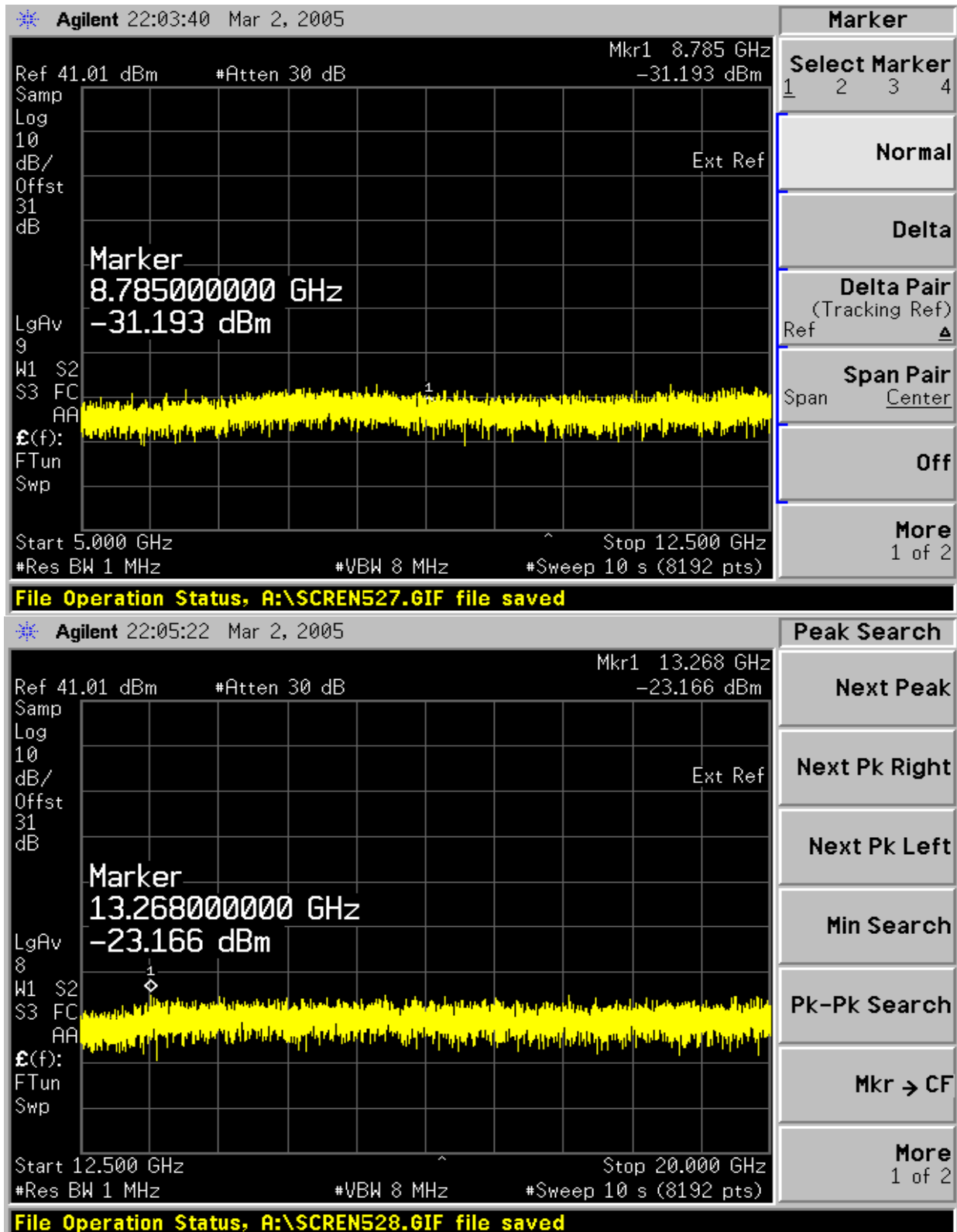


**Figure 33 : Conducted Spurious Emissions - Channel 825 (Uppder Adjacent 1 MHz to 5 GHz)**

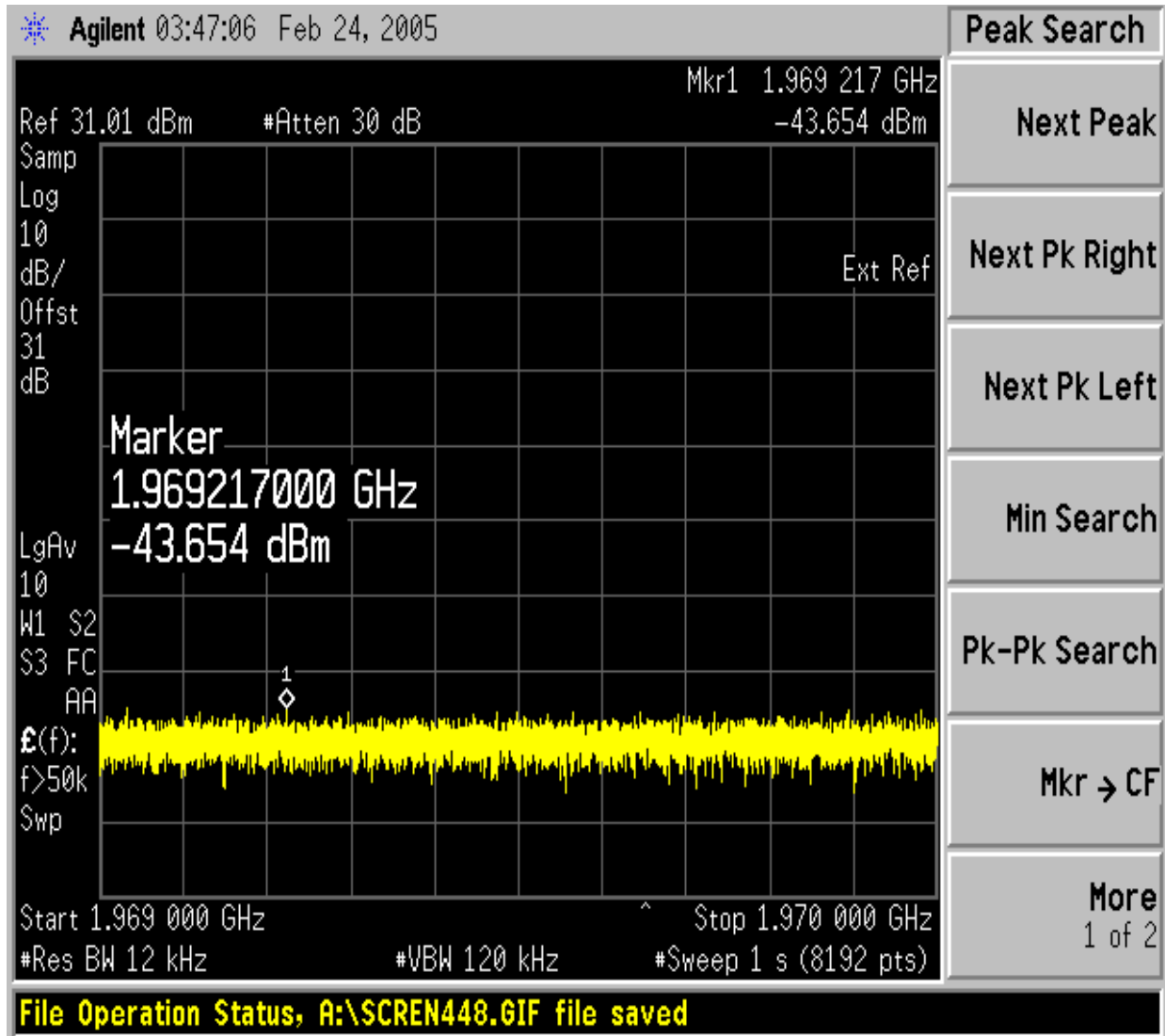




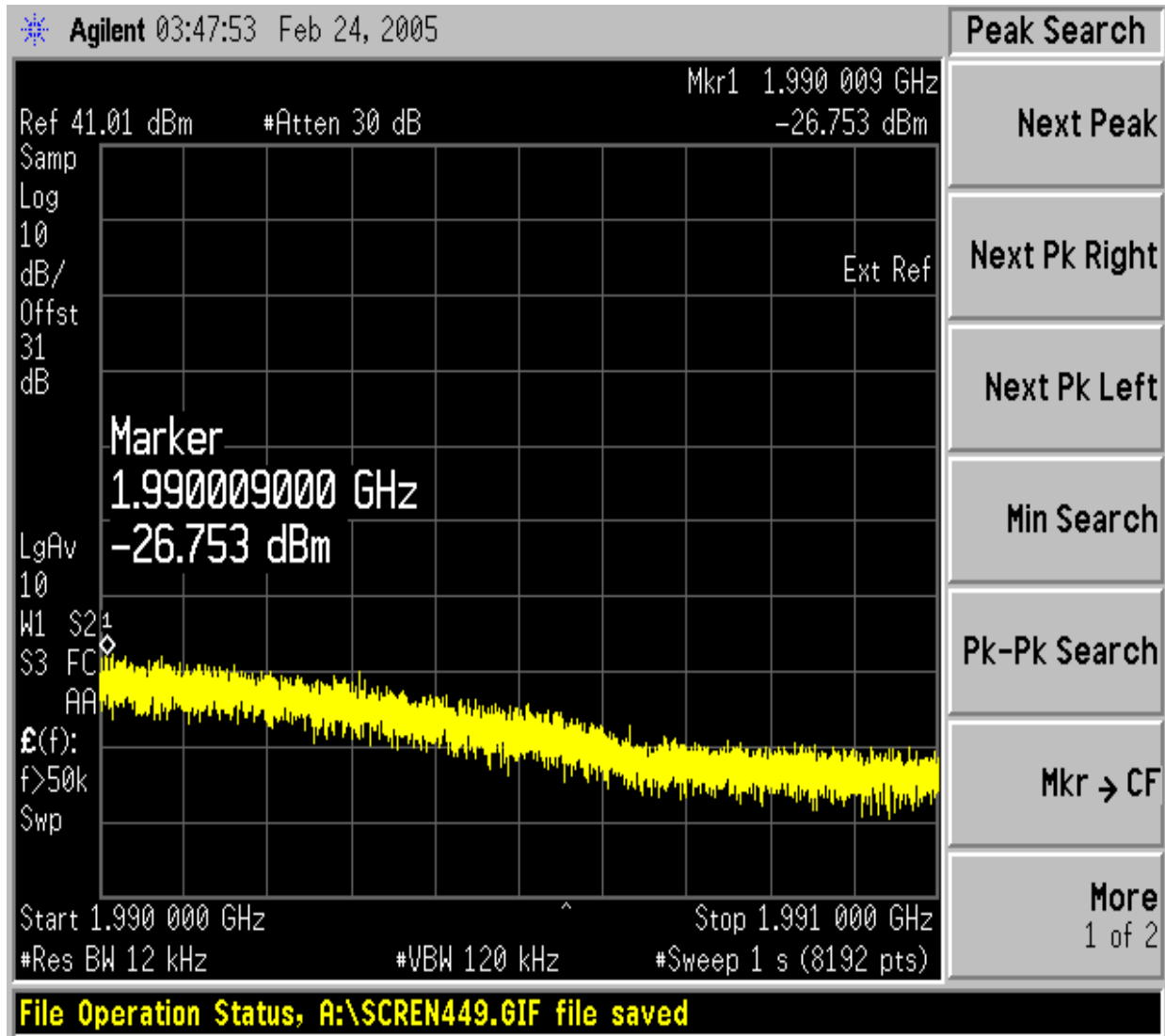
**Figure 34 : Conducted Spurious Emissions - Channel 825 (5 GHz to 20 GHz)**



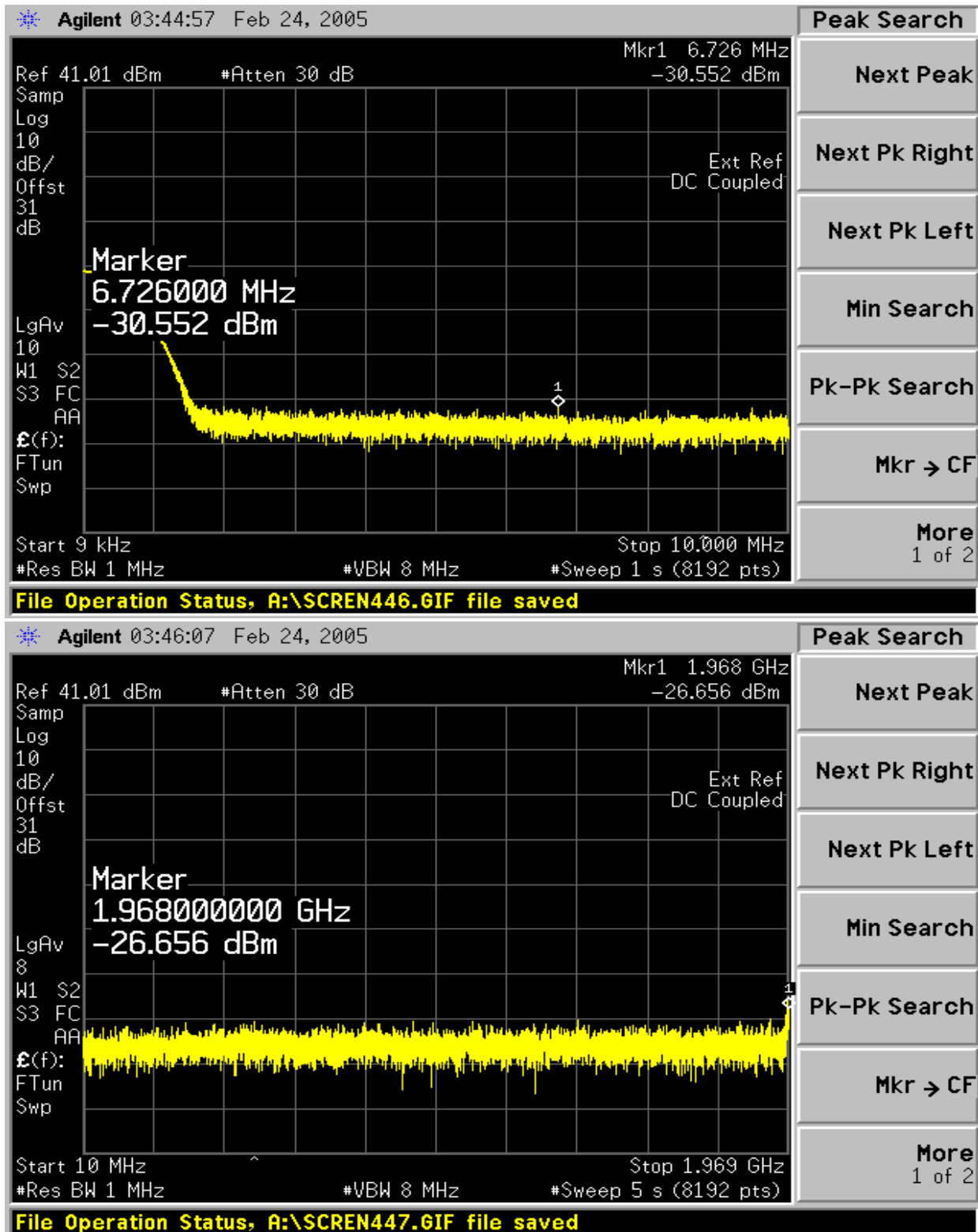
**Figure 35 : Conducted Spurious Emissions - Channel 1175 (Lower Adjacent 1 MHz)**



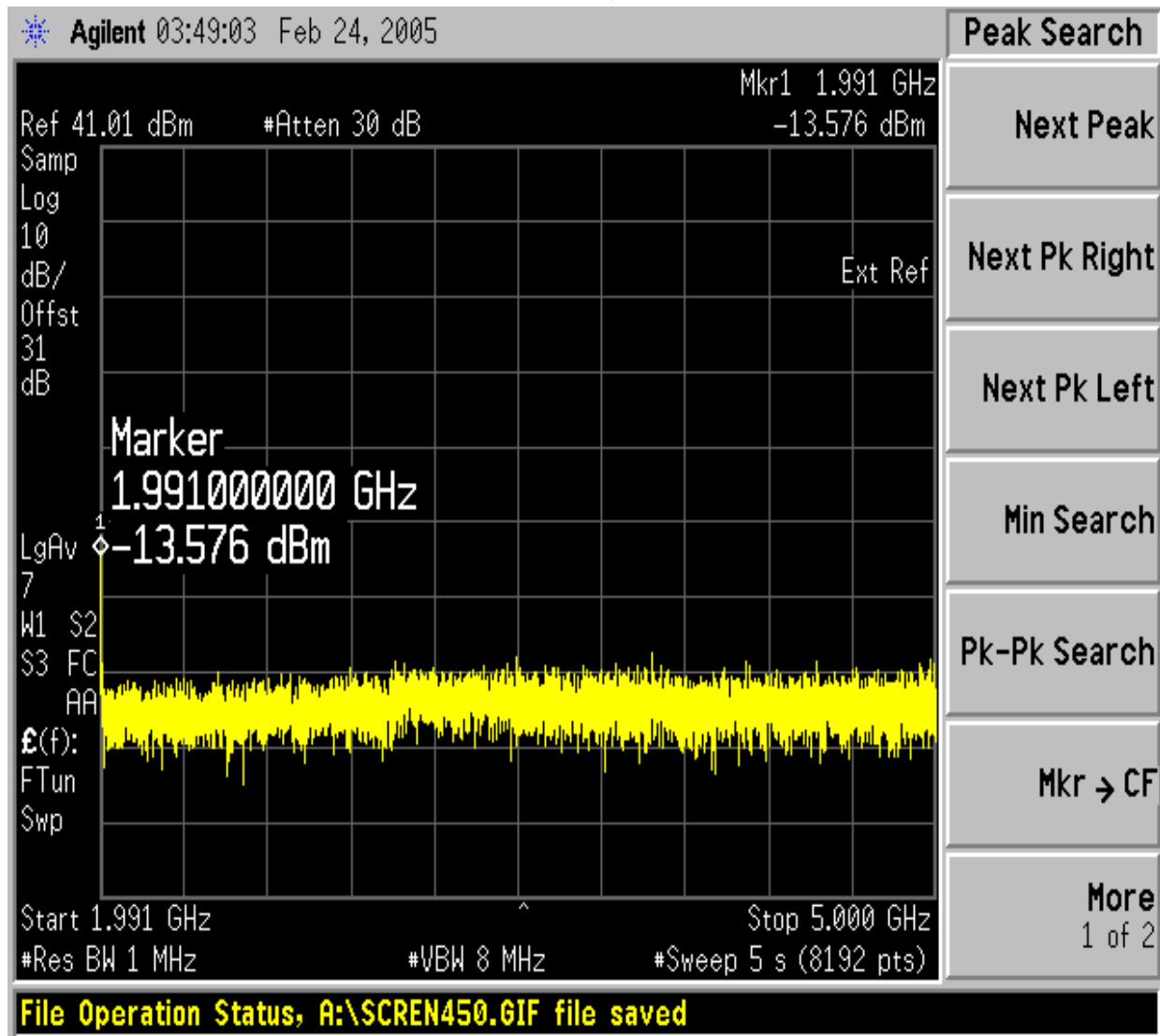
**Figure 36 : Conducted Spurious Emissions - Channels 1175 (Upper Adjacent 1 MHz )**



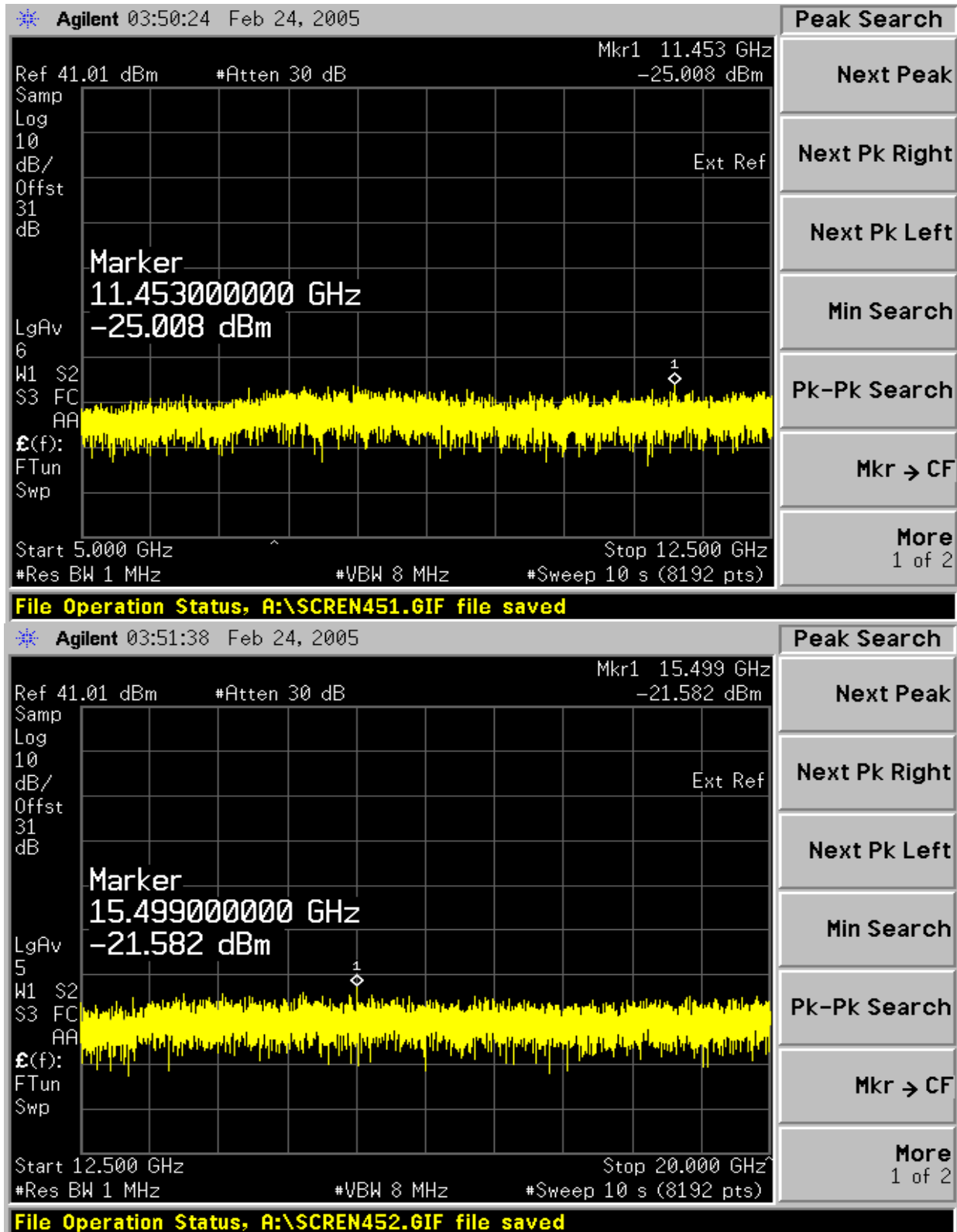
**Figure 37 : Conducted Spurious Emissions - Channel 1175 (9 KHz to Lower Adjacent 1 MHz)**



**Figure 38 : Conducted Spurious Emissions - Channels 1175 (Upper Adjacent 1 MHz to 5 GHz)**



**Figure 39 : Conducted Spurious Emissions - Channels 1175 (5 GHz to 20 GHz)**





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## References

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- [2] FCC Part 2 Subpart J, “Frequency allocations and radio treaty matters; general rules and regulations”, [http://www.access.gpo.gov/nara/cfr/waisidx\\_00/47cfr2\\_00.html](http://www.access.gpo.gov/nara/cfr/waisidx_00/47cfr2_00.html)
- [3] Industry Canada RSS-133, “2 GHz Personal Communication Services”, <http://strategis.ic.gc.ca/SSG/sf01520e.html>
- [4] ANSI-97-E “Recommended Minimum Performance Standards for cdma2000 Spread Spectrum Base Stations”, December 2002
- [5] Industry Canada “Information on the 99% Bandwidth measurement” Author Brain Kasper. [http://strategis.ic.gc.ca/epic/internet/inceb-bhst.nsf/vwapj/occupied-bandwidth.pdf/\\$FILE/occupied-bandwidth.pdf](http://strategis.ic.gc.ca/epic/internet/inceb-bhst.nsf/vwapj/occupied-bandwidth.pdf/$FILE/occupied-bandwidth.pdf)
- [6] Indoor Compact Metro Cell Systems Design Specification, Dataset Name: NTGY00AA, Document Status: Approved, Stream: 01 Issue: 03, Issue Date: September 4, 2003, Original Owner: Roman Nemish, Wes Mundy.
- [7] Nortel Networks BTS Development Group 800MHz / 1900MHz Compact Metro Cell Radio Module General Specifications, Dataset Name: GSRZ71AA\_CA, Document Status: Update, Stream: 00 Issue: 02.2, Issue date: Feb 19, 2004, Originator: Feng Gao



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